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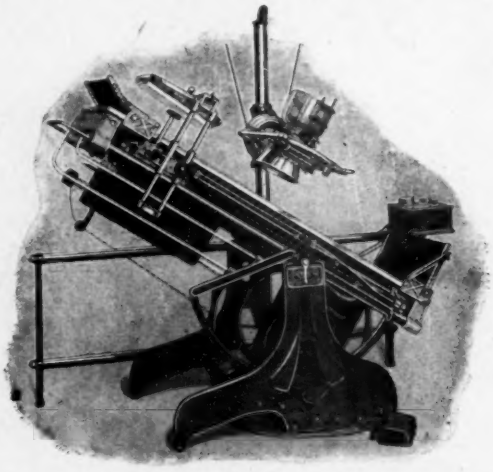

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THE AMERICAN JOURNAL OF ROENTGENOLOGY

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STUDIES IN REDUCTION OF BONE DENSITY*

By D. B. PHEMISTER, M.D.

CHICAGO, ILLINOIS

REDUCTION in bone density occurs either from a retardation of bone deposition in the presence of normal bone absorption, or from excessive bone absorption. Retarded deposition occurs in disorders of calcium metabolism, such as rickets and osteomalacia. Calcium absorption goes on at the normal rate, and new connective tissue framework or osteoid tissue continues to form but fails to ossify. This is one of the factors that result in gradual reduction of the calcium content and replacement by fibrous tissue. Reduction in density from excessive bone absorption occurs almost entirely as a result of regional or local disturbances produced by disease, injury or loss of function. This discussion will be limited to reduction in density produced by bone absorption.

Lime salts may be removed from the bone by two processes: first, solution by the serum, leaving the connective tissue framework behind, and, second, cellular activity, where the bone is directly attacked by fixed tissue cells, removing both lime salts and stroma. Solution of lime salts by the serum, leaving behind the connective tissue framework, is said to occur in rickets and osteomalacia. Von Recklinghausen described the process as halisteresis, and claimed that by means of special stains and gas injections of the fresh bone he could demonstrate empty spaces from which the lime salts had been absorbed. Recent histologic studies, especially by Axhausen, cast much doubt upon the occurrence of such a process, and show that bone absorption is produced almost entirely by the direct action of fixed cells known as osteoclasts. The osteoclast may be an abnormal cell, as in tumors or inflammations, or it may arise from alteration in function of the cells in the vicinity. Cells may be converted into osteoclasts without change in form, or they may be transformed into giant cells. In many processes the greater amount of bone is absorbed by cells without any alteration in their morphology. The nature of the reaction by which the cell produces absorption of the lime salts is imperfectly understood, but it is probably by the creation of an acid medium in direct contact with the bone, which results in its solution. The field of absorptive activity is confined to a comparatively narrow space about the cell.

There is no specific osteoclast, and a variety of cells may possess this absorptive power in common. Most bone absorption is produced by fibroblasts and endothelial cells whose functions have been altered, or by giant-celled osteoclasts, to which they give rise. Tumor cells and inflammatory cells of

*Read at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Minneapolis, Minn., Sept. 14-17, 1920.

various types may possess the power of bone absorption. Different histologic pictures arise in the process of absorption, in which the osteoclasts attack the surfaces of the bone absorbed, eating various-sized and shaped pockets in it. Smooth absorption is another form in which lime salts disappear from cellular activity along the walls of the haversian canals without extensive pocket formation. Volkmann's canalization is the process in which marked dilatation of the transverse or communicating canals is produced by greater absorption in their vicinity than occurs along the haversian system. Ernst and von Muralt have described the condition of lamellar splitting off and fragmentation produced by tumor cells which invade the interlamellar spaces.

Reduction in density may be local, regional or general, according to the cause. In most local processes there is both local and regional reduction in density, and if general symptoms are marked and extend over a long period of time with confinement to bed, there may be general reduction in density. The fields for discussion here have been chosen more or less at random, without any attempt to cover the entire subject. The object is not

FIG. 1. Staphylococcus bone abscess of external supracondylar region of humerus. *a*—Area of bone destruction without sequestrum formation.

FIG. 2. Acute osteomyelitis of tibia of eleven days' duration. Small, irregularly distributed areas of reduced density in end of shaft, being the earliest *x*-ray findings in osteomyelitis. Subsequent changes showed in entire length of shaft.

so much to show roentgenologic features of reduced density as the histologic processes by which the bone is destroyed.

In bone infections there are four processes by which reduction in density may be produced: first, there is destruction of dead bone at the seat of greatest inflammatory activity; second, there is local destruction of living bone, or caries; third, there is rarefying osteitis in the neighboring living bone for variable distances about the area of complete bone destruction; and, fourth, there is regional atrophy of disuse. The amount of each of these forms varies considerably with the nature and severity of the inflammatory process, and is of considerable importance in the differential diagnosis of inflammatory bone changes. There are no specific destructive changes for the individual inflammatory processes, any more than there are specific productive changes. The description which follows is of the usual reduction in density which occurs in the various inflammatory processes to be enumerated.

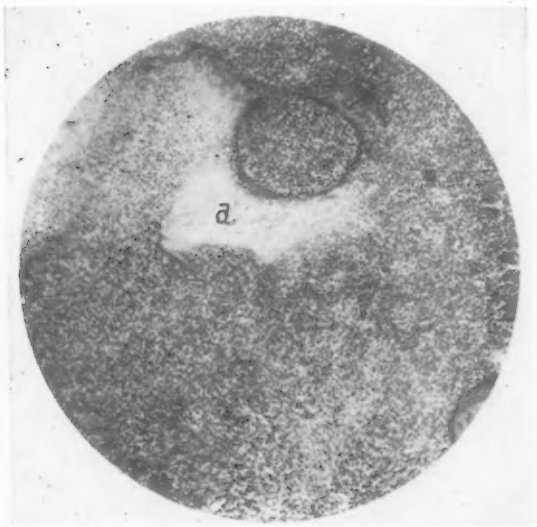

FIG. 3. Bone destruction in osteomyelitis of two weeks' standing, produced by fresh granulations before the appearance of giant-celled osteoclasts. *a*—Dead bone.

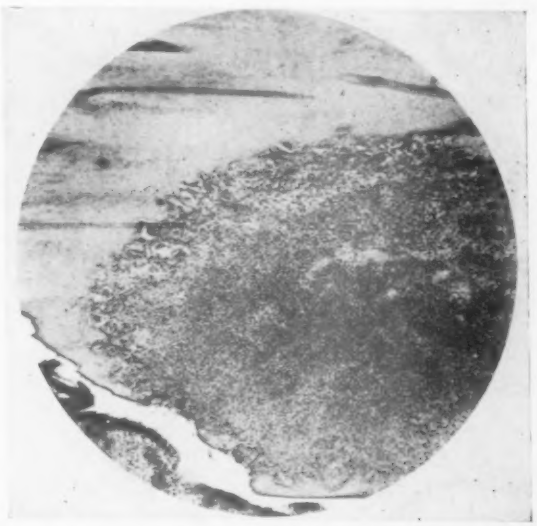

FIG. 4. Lacunar absorption of sequestrum of two months' standing by giant cells and maturing fibroblasts. Note the lacunae along the entire line between dead bone and granulations.

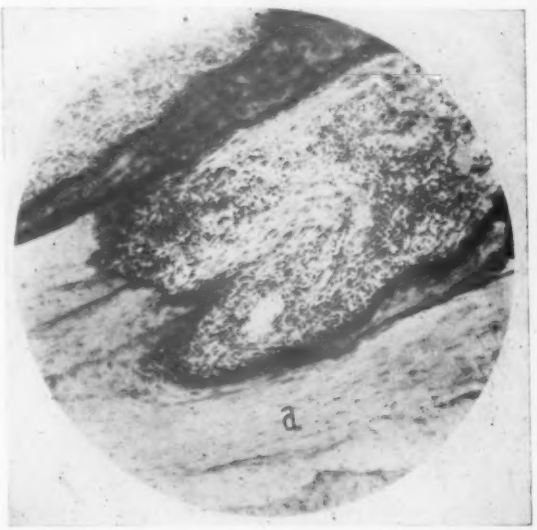

FIG. 5. Rarefying osteitis about periphery of osteomyelitis of fibula of ten weeks' standing. Shows absorption by maturer type of inflammatory tissue. *a*—Living bone.

Osteomyelitis.—Necrotic bone results from the effect of the toxins in the most severely inflamed region. The unossified elements of the dead bone are rapidly killed by toxins and removed by the action of the serum and leucocytes, but the calcareous deposits are little affected during the height of the inflammation, because practically they are only removed as a reparative process by the absorptive action of the granulations, and some time is required for the development of reparative changes and the absorption of

sufficient bone to produce evidences of reduction in density. From six to fifteen days elapse, depending upon the size of the bone and the location of the infection, before signs of reduction in density can be shown by the *x*-ray. If the osteomyelitis is a diffuse process, the reduced density shows first in small scattered areas of the metaphysis, and evidence of involvement of thicker portions of cortex appears later.

Absorption of living bone in considerable quantity occurs about the margin of dead bone, helping in the sequestration of the dead bone and leading to cavity formation. This process is known as caries. Early in osteomyelitis the absorption of both living and dead bone is produced by active granulation tissue. After the acute inflammatory stage has subsided, the granulations become somewhat more mature and large numbers of giant cells appear, interspersed among the fibroblasts. Lacunar absorption is the process by which the lime salts are removed in both stages. Figure 1 shows an abscess cavity in localized osteomyelitis, produced by the rapid destruction of spongy bone, and Figure 2 small scattered areas of destruction in the metaphysis, showing early in diffuse osteomyelitis. Figure 3 shows the type of granulation tissue in the early stage, producing the absorption of both the dead and living bone in the formation of such areas. Figure 4 shows the maturer type of granulations and giant cells producing absorption of the dead bone some time after the acute inflammatory stage has subsided. The rate of destruction of dead bone by granulations depends to a considerable extent upon its relation to living bone. The surfaces of dead bone that are adjacent to living bone, as dead cortex is to involucrum, become extensively eroded from the action of granulations that are maintained in contact with them by the living bone. But surfaces remote from living bone frequently show little evidence of destruction, because of the absence of a bony background for the granulations. Large surfaces of dead cortex, uncovered by involucrum, may remain uneroded for months and the bone preserve its original density. Erosion of dead bone reduces its density, but the reduction is uneven because of the fact that destruction is of a worm-eaten type, as contrasted with the even reduction in density of atrophied living bone.

Rarefying osteitis arises from extension of the inflammation for a variable distance into the surrounding living bone. It results in the absorption of numerous, irregularly distributed, small areas of cortex or spongiosa, which shows in roentgenograms in from two to six weeks as corresponding areas of reduced density. Absorption in this process is produced early by the action of fresh granulation tissue, and at a later stage by mature connective tissue and giant cells. Extensive rarefying osteitis is seen in Figure 6. Figure 5 shows histologically rarefying osteitis in osteomyelitis of the fibula of ten weeks' standing. Rarefying osteitis is often entirely absent, especially in localized bone infections.

Regional Atrophy.—Atrophy of the living bone of the involved region results from disuse, and its severity depends upon the degree and duration of the disability. It may also be caused partly by the alteration in circulation and by the toxicity of the part. The first *x*-ray evidences of it are seen in the spongy bone in from two to four weeks. It is frequently spotted in this location, especially when the process has become advanced. It appears later in the cortex, and is somewhat more marked in the endosteal than in the periosteal region. Because of the greater absorption of cortex from within outward there may be considerable increase in diameter of the medullary canal. Absorption occurs along the course of the haversian canals, and when marked may give rise to longitudinal streaking in the roentgenograms. Figure 7 shows reduced density and longitudinal streaking of cortex in a specimen of marked eccentric atrophy of the femur. Bone absorption in regional atrophy is produced largely by the action of simple fibroblasts arranged along the surfaces of the lamellae. The surfaces may remain smooth, and there

is absence of giant cells and lacunae in large numbers as contrasted with the destruction in the areas of inflammation where lacunae form. Figure 8 is of a cross section of an ulna showing marked eccentric atrophy and dilated haversian canals, the result of disuse, seven months after excision of a more dis-

presence of large numbers of lacunae is more indicative of inflammatory action than of simple atrophy of disuse.

Tuberculosis.—Tuberculosis usually produces localized osteitis, diffuse tuberculous osteomyelitis of the shaft being a comparatively rare occurrence. The metaphyseal re-

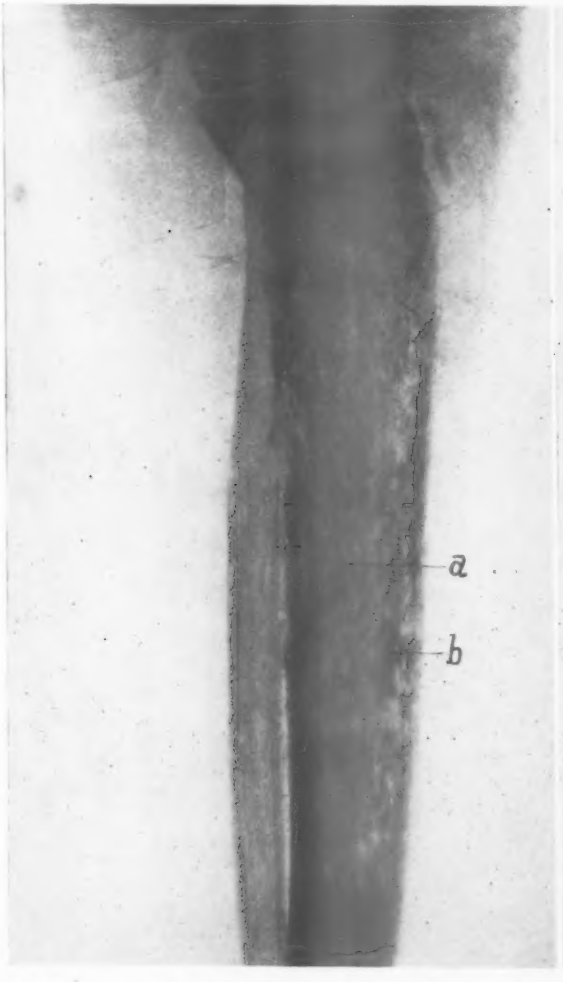

FIG. 6. Osteomyelitis of tibia, fifty-four days' duration, with (*a*) rarefying osteitis, (*b*) sequestrum formation and beginning regional atrophy in the non-osteomyelitic portions.

FIG. 7. Reduced density and longitudinal streaking in marked eccentric atrophy of disuse of femur.

tally located segment of the bone for sarcoma. Figure 9 shows the histologic appearance of a markedly atrophied cortex in the vicinity of an infected compound fracture of nine months' duration. It shows smooth absorption by fibroblastic osteoclasts along the surfaces of the lamellae. In general, the

gion of the end of the bone is more frequently involved primarily, especially during the first decade. After the tenth year primary foci in the epiphyses are seen with increasing frequency. The lesion in either case causes death of bone in a circumscribed area, which because of the vascular arrangement is frequently cone shaped and in other cases roughly spherical.

The bone is frequently destroyed as rapidly as it dies, so that no sequestra are left in the field, and only cavity formation is seen in the *x*-ray (Fig. 10). In other instances where rapid death occurs, a line of demarcation forms and a sequestrum is left (Fig. 11). In this case reduced density is seen, indicative of the presence of a cavity which contains a sequestrum casting a shadow of the density of the bone at the time of its death.

FIG. 8. Cross-section of ulna showing eccentric atrophy and dilated haversian canals, the result of disuse.

Caries of the adjacent living bone may lead to gradual enlargement of the cavity after the early and more acute stage is passed. Lacunar absorption of the living and dead bone in the tuberculous focus is produced by the action of the granulations and giant-celled osteoclasts. Epithelioid and Langhans' giant cells are not seen to produce bone absorption, although they may be present in the immediately surrounding tissue (Fig. 13).

FIG. 9. Marked dilatation of haversian canals of cortex of humerus from smooth absorption in regional atrophy and dilated haversian canals, the result of disuse in osteomyelitis.

FIG. 10. Tuberculous caries of upper metaphysis of humerus, producing large area of reduced density without sequestrum formation. Note laminated periosteal new bone laterally.

Rarefying osteitis from irregular spread

of the tuberculous infection into the surrounding living bone is not seen, except in the rare cases of diffuse tuberculous osteomyelitis, in which event density is irregularly reduced, as in similar cases of pyogenic osteomyelitis.

FIG. 11. Cone-shaped tuberculous focus of metaphysis in lower portion of neck of femur. Its periphery shows reduced density from caries, while the center shows normal density due to presence of (*a*) sequestrum.

Regional atrophy occurs in tuberculosis, as in pyogenic infections of the bones, and produces the same histologic picture and type of reduced density as shown by the *x*-ray. It is frequently extreme, because of the protracted and painful nature of the disease.

In tuberculous arthritis, either primarily synovial or secondary to rupture of an osseous focus, a variety of changes may occur in the articular surfaces of the bones. Ingrowth of tuberculous granulation tissue beneath the articular cartilage, from about its margins, is a common occurrence, leading to destruction of the articular cortex of bone and to disappearance of the sharp line which it normally casts in the *x*-ray. Ordinarily the overlying articular cartilage is soon destroyed by the action of the granulations, so that not

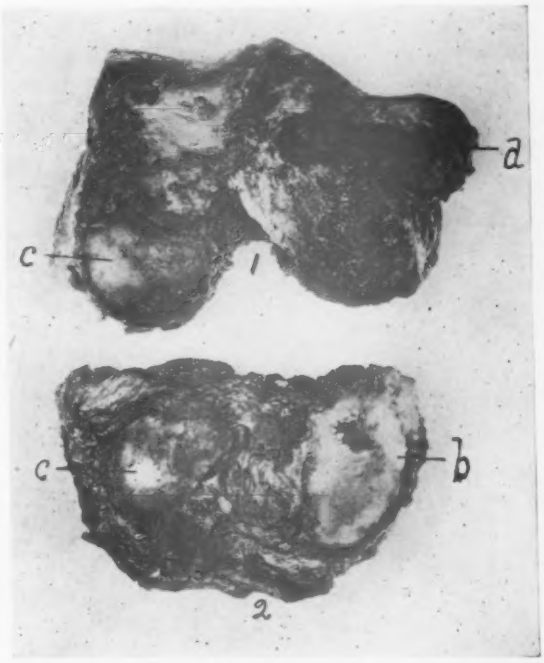

FIG. 12. Articular surfaces of (1) femur and (2) tibia from resected tuberculous knee of one year's duration. *a*—Undermined cartilage displaced, *b*—undermined cartilage in position, *c*—islands of attached cartilage.

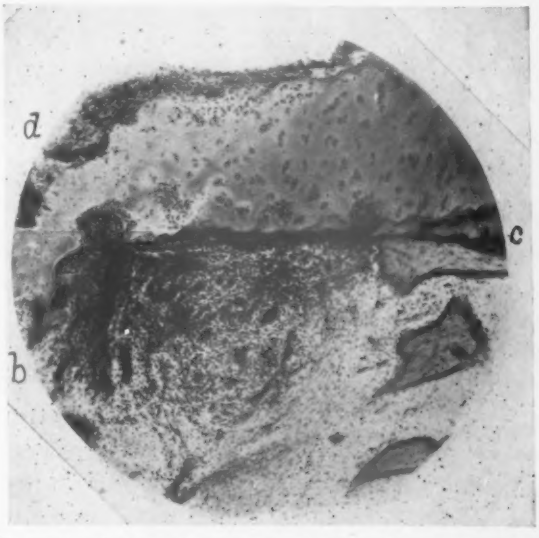

FIG. 13. Tuberculous granulations showing *a*—destruction of articular cartilage from the joint side and *b*—destruction of bone with undermining of cartilage; at *c*—bone and cartilage are unaffected.

only the articular margin of the bone is removed, but the cartilage space of the joint is markedly narrowed or obliterated. However, a considerable amount of the undermined articular cartilage may remain for some time after destruction of its underlying bony attachment, as is frequently seen at operation and is shown grossly in Figure 12 and microscopically in Figure 13. In such cases the cartilage space may be largely preserved in the roentgenogram, even though the sharp line cast by the articular cortex is fragmented or destroyed.

In other cases the tuberculous process invades and produces necrosis in certain areas of the ends of the bones, frequently to the depth of one or two centimeters. The dead bone subsequently either breaks down or becomes separated as sequestra. If the bony invasion occurs primarily or early in the course of the tuberculous arthritis, before regional atrophy has developed, the sequestra consist of unatrophied bone and subsequently cast a heavier shadow in the *x*-ray than the surrounding living bone which atrophies (Fig. 14). If the bony invasion occurs late and after the regional atrophy has developed, the shadows cast by the sequestra are of the same density as that of the surrounding living bone.

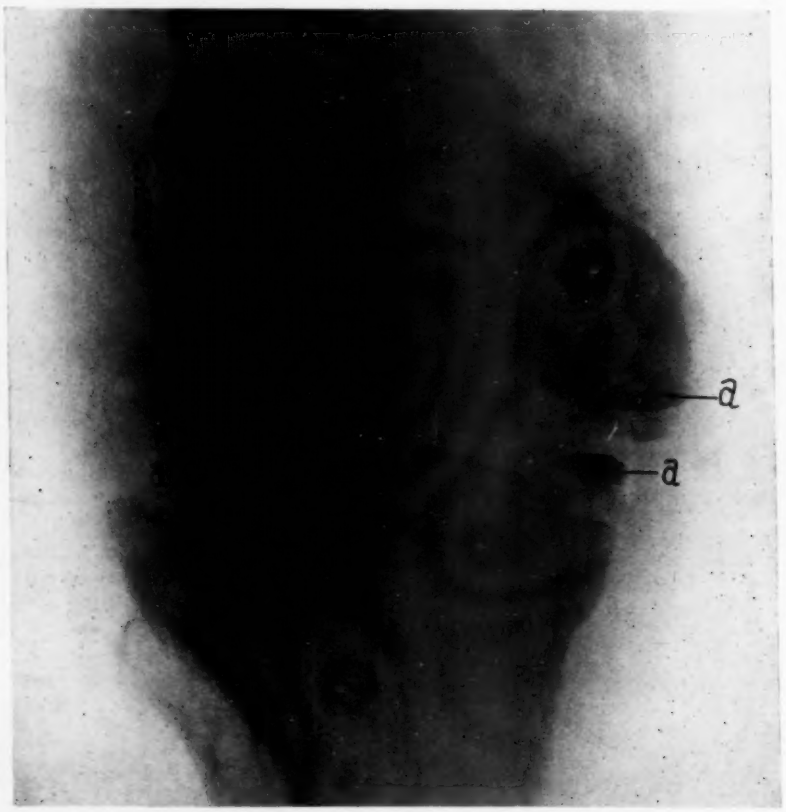

FIG. 14. Tuberculosis of knee of two years' duration with invasion of condyles and internal tuberosity and (*a*) sequestrum formation. Sequestra have sharp articular surfaces and are denser than surrounding living bone which subsequently atrophied.

Syphilis.—Bone syphilis produces gummatous caries in irregularly distributed and various-sized areas (Fig. 15). This may shade off into rarefying osteitis of the surrounding bone. A single area of reduced density of long duration speaks against syphilis, as the process usually extends, leading to multiple areas of bone destruction. Sequestra of appreciable size are rarely seen in syphilis of the long bones, but are sometimes found

in extensive involvement of the skull. Regional atrophy of the living bone is usually slight or absent in syphilis, because function is less interfered with than in osteomyelitis or tuberculosis. Hence reduction in density in bone syphilis takes the form of localized, irregularly distributed, large and small areas. They are frequently interspersed with shadows from new bone formation. Hypertrophic sclerosing syphilis with great increase in density usually shows small, irregular areas of reduced density, which are of great help in the *x*-ray recognition of the nature of the disease.

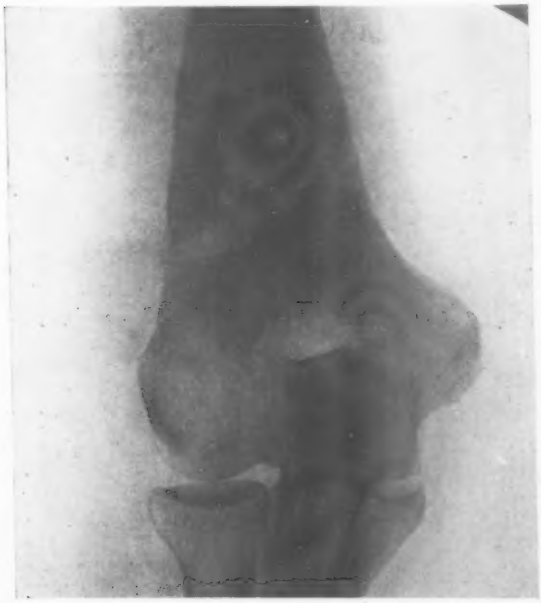

FIG. 15. Acquired syphilis of humerus of twenty months' duration. Numerous irregularly distributed, various-sized areas of reduced density and surrounding areas of increased density.

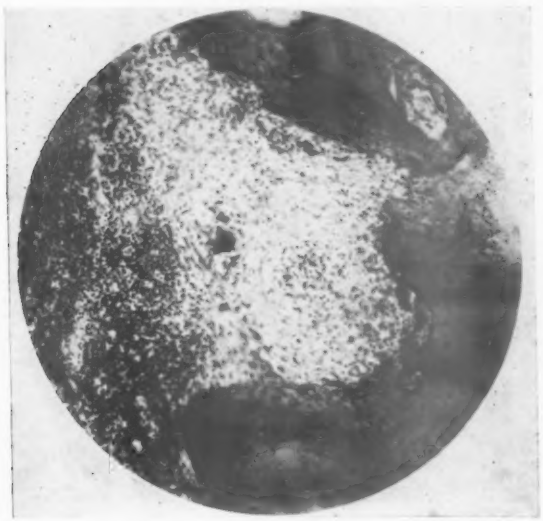

FIG. 16. Syphilitic caries of skull, showing bone destruction and gummatous tissue.

FIG. 17. Metastatic osteoclastic carcinoma from breast, almost completely destroying radius.

Histologically bone destruction with marked lacunar formation is produced by gummatous tissue. Fibroblasts and giant-celled osteoclasts produce the destruction, but epithelioid and syphilitic giant cells may be seen in close proximity to bone that is being eroded (Fig. 16).

Bone Tumors.—Reduction of density in bone tumors results almost entirely from breaking down of living bone by cellular

activity. However, aseptic dead bone may occasionally be seen where portions of cortex are cut off and completely surrounded by tumor which undergoes necrosis. Regional atrophy may also arise from disuse, where

FIG. 18. Carcinoma metastasis of femur from breast, with absorption produced by non-tumorous giant cells. *a*—Carcinoma islands. *b*—Row of osteoclasts.

the tumor produces pain and much loss of function. Bone destruction reducing density is accompanied by extremely variable amounts of new bone formation, and the extent and distribution of the two must be taken into consideration in the recognition of the nature of the lesion.

Carcinoma.—In metastatic carcinoma of the bones, the relative amounts of bone destruction and new bone formation bear some relation to the seat of the primary tumor and its degree of malignancy and rate of growth. Thus metastatic carcinoma of the breast tends to produce bone destruction with little associated new bone formation, while carcinoma of the prostate produces little bone destruction and much new bone formation. However, slowly growing scirrhous cancer of the breast may produce marked ossification, and medullary carcinoma of the prostate occasionally produces marked absorption of bone with little associated ossification. Reduction in density arises from absorption of tumor which lodges and develops in the interior of the bone, whether shaft or cancellous portion is involved. Superficially situated metastases producing destruction from without inward are extremely rare. Very marked absorption affecting the entire length of a bone occasionally occurs without appreciable extension of the tumor beyond the normal limits of the bone. Figure 17, an extreme example, is of a metastasis in carcinoma of the breast, in which the radius was almost entirely destroyed without appreciable tumor formation in the forearm. Histologically the absorption is produced largely by the action of fibroblasts and giant cells, which form a narrow zone between the growing carcinoma and the bone that is being eroded. Figure 18 shows this process in osteoclastic metastasis of the femur, secondary to carcinoma of the breast. Carcinoma cells may also act as osteoclasts, coming in direct contact with the bone and leading to its absorption. However, their rôle is a minor one in the process of bone destruction. Figure 19 shows tumor osteoclasts in the same case as Figure 18. But even in this field

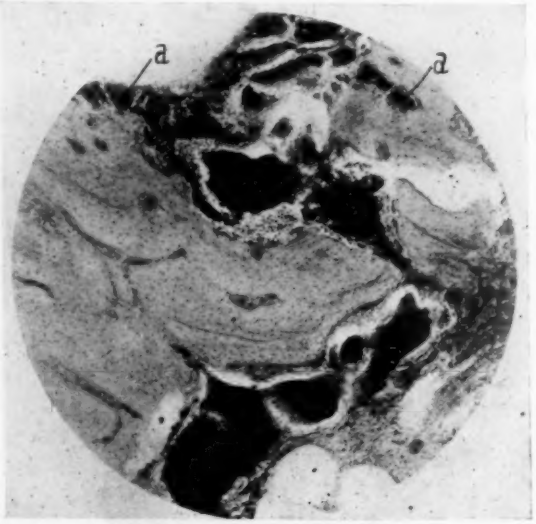

FIG. 19. Same case as Figure 18, showing bone absorption by carcinoma cells. *a*—Carcinoma osteoclasts.

many of the osteoclasts are mesoblastic cells. After the lime salts have been removed, the decalcified stroma and bone cells may not be immediately destroyed, and sometimes may

be seen as a narrow layer separating tumor from bone. Arey claims that bone cells thus liberated may be converted into osteoclasts and in turn take part in the process of bone absorption.

Sarcoma.—Reduction in density in sarcoma usually occurs *en masse,* and while the outline of the area of destruction may be irregular, extensive pocket formation and adjacent islands of destruction are uncommon. The appearance of trabeculation and pocketing may be produced by new bone formation. The area of destruction in sarcoma, beginning about the periphery of the bone, is usually in the shape of a shallow depression along the surface of the shaft (Fig. 20). If the involved cortex is thinner at one end than at the other, the depth of the destruction may be greater at the end where the cortex is thinner, because of the greater ease with

FIG. 20. Primary peripheral sarcoma of tibia, producing irregular, shallow, concave destruction of cortex of tibia and, by secondary involvement, of fibula.

which extension occurs into the deeper portion after the thin cortex has been eroded. Central sarcoma of the malignant type erodes the bone from the endosteal side, and usually more extensively in a particular segment of the cortex where it breaks through and forms

FIG. 21. Sarcoma eroding cortex of fibula by direct action of tumor cells. *a*—Tumor osteoclasts. *b*—Osteoporosis preceding tumor and produced by non-tumor cells.

an external tumor. Sometimes diffuse invasion occurs, followed by the appearance of a superficial tumor without extensive destruction of cortex. Erosion of cortex from the endosteal side may occur in primary peripheral sarcoma after the tumor has broken through one side and invaded the medullary canal, so that cortex opposite the point of onset may eventually be destroyed. The bone destruction in sarcoma is due largely to the osteoclastic action of tumor cells, as contrasted with carcinoma, where connective tissue cells produce most of the breaking down. Figure 21 shows bone absorption in round and spindle-celled peripheral sarcoma of the fibula, in which the osteoclasts are mainly tumor cells, and Figure 22 shows similar tumor cell absorption in a sarcoma of the humerus. Microscopic examination of bone about the limits of a spreading sarcoma sometimes shows marked osteoporosis, which is produced by non-tumorous fibroblasts and giant-celled osteoclasts, as at *b* in Figure 21. In some cases this may be very marked and extend to a distance of one or two centimeters away from the tumor, as in Figure 23, which is of the cortex located about one centimeter beyond the limits of the tumor shown in Figure 22. In round and spindle-celled sarcomas giant cells are frequent along the zone of absorption, and it is difficult to state whether or not they are neoplastic in origin.

New bone formation in the ossifying types of sarcoma may be sufficiently extensive to offset the reduction in density resulting from bone destruction, but its distribution and arrangement are usually such that the shadows cast are of diagnostic significance.

Central giant-celled tumors affecting the ends of the long bones form a special group, and it is still a question if they should be classified with sarcomas. They reduce bone density by eccentric growth and are entirely devoid of any tendency to undergo ossification. Erosion of the cancellous bone, and then of cortex, proceeds and may eventually lead to complete destruction of the surrounding

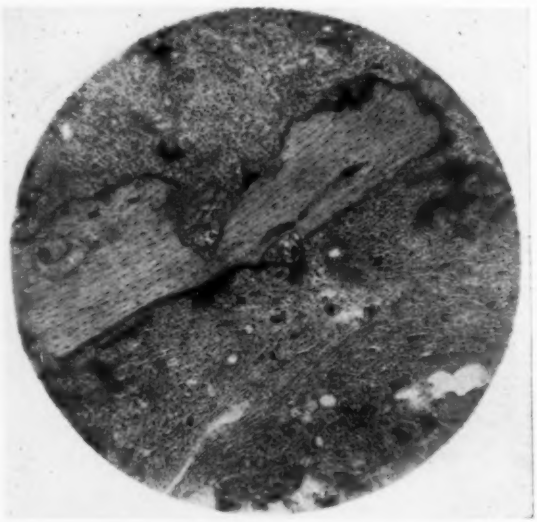

FIG. 22. Tumor-celled osteoclasts destroying cortex in sarcoma of humerus.

old bone. As this occurs, globular enlargement of the affected region is usually observed. In some instances the cortex is destroyed without associated periosteal new bone formation, and pathological fracture may result. In other cases, periosteal new bone formation occurs synchronously with

eccentric erosion by the tumor, so that a cortex of bone is maintained during the process of enlargement. Portions of the original cortex are rarely preserved in the expanded regions after the tumor has reached considerable size, but during the early stages they may be outwardly displaced and form

FIG. 23. Marked osteoporosis of portion of cortex, preceding spread of tumor in Figure 22.

part of the shell. Histologically these tumors consist of a groundwork of fibroblasts in various stages of maturation interspersed with a variable number of giant cells. There is considerable variation in vascularity. Mitotic figures and cell division are practically never seen, and the tumor has no microscopic appearances of malignancy. Bone erosion is produced largely by fibroblasts, there being no increase in the number of giant cells along the eroded surfaces above that contained in the interior of the tumor. The giant cells present along the periphery of the bone are of the type of osteoclasts seen in other destructive processes, while the giant cells of the tumor are frequently much larger and their cytoplasm may take a deeper acid stain. They are probably syncytial cells derived from the endothelium of the blood vessels. Figure 24 shows giant-celled tumor erosion of the cortex to the point of almost complete destruction without any new bone formation by the periosteum. Figure 25 shows enormous enlargement of the upper end of the humerus with the formation of an incomplete shell-like cortex by the periosteum as the interior destruction occurred. Figure 26 shows the process of peripheral new bone formation with slight destruction occurring from the inside. Note the small number of giant cells along the surface of bone about each tumor.

Bone absorption in benign tumors, as enchondromas and fibromas, is produced by fibroblasts and occasional giant-celled osteoclasts. The tumor cells exert no direct osteoclastic action.

Cysts.—In bone cysts the reduction in density is quite similar to that in giant-celled tumors, in that the process begins in the interior of the bone and produces eccentric erosion, without subsequent ossification of the tissue which caused the erosion. Aside from the fact that the cysts are more inclined to occur in younger individuals and to affect the shaft away from its ends, they also differ from giant-celled tumors in that extensive

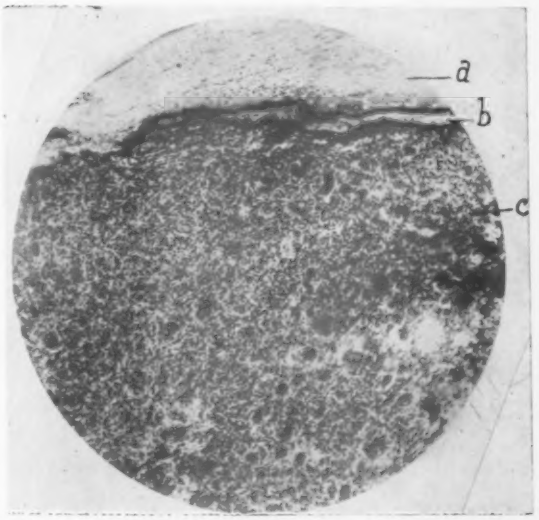

FIG. 24. Central giant-celled tumor erosion of cortex without periosteal new bone formation. *a*—Periosteum. *b*—Remnant of eroded cortex. *c*—Tumor. Note absence of tumor giant cells along surface of bone destruction.

destruction of cortex and marked enlargement of the involved region are rarely seen. However, small perforations of cortex are not uncommon, and secondary periosteal new bone formations may occur. Rarely cortex may be rapidly eroded and periosteum great-

FIG. 25. Central giant-celled tumor with shell formation. No ossification within the tumor. Trabeculae of cortical new bone.

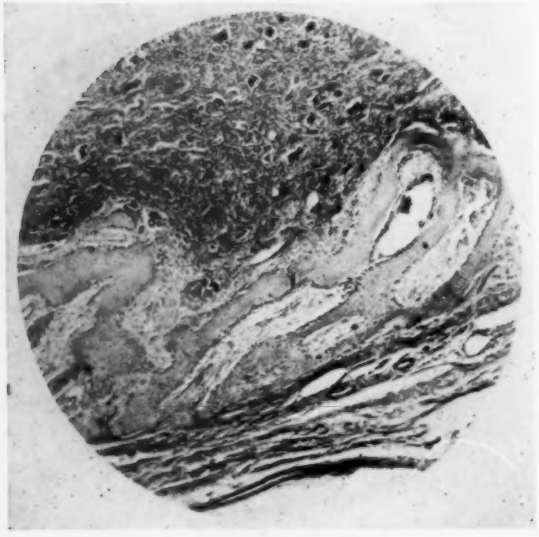

FIG. 26. Section of cortex in Figure 25, showing layer of periosteal new bone with tumor and destruction along its internal surface.

ly distended with marked enlargement of the part. Figure 27 shows a roentgenogram and Figure 28 the excised specimen of a large cyst of eight months' standing in the third metacarpal bone of a twenty-year-old woman, in which the cortex was extensively destroyed, periosteum greatly distended, and only a thin layer of new bone formed about its limits. The bone destruction occurs from within outward by the action of the cells of the fleshy lining of the cyst. Fibroblasts and giant-celled osteoclasts produce lacunar absorption along the surface and invade and dilate the haversian canals for some distance. Giant-celled activity is much more in evidence in the bone destruction of cysts than in that of giant-celled tumors. Figure 29 shows the destruction of old cortex and Figure 30 the structure of cyst wall in its thinnest portion in the last case with signs

of absorption from within outward. This specimen shows that breaking through of old or even of newly formed cortex is no criterion for distinction between giant-celled tumor and bone cyst. Trabeculation occurs in both cysts and giant-celled tumors, and

FIG. 27. Cyst of third metacarpal bone of nine months' duration in twenty-year-old woman. Cortex destroyed except at proximal end. Periosteum distended and has formed thin layer of bone about most of the periphery of cyst.

is peripheral in its location in both processes. It is due to the formation of shallow pockets from internal erosion and irregularly distributed new bone formation on the part of the periosteum.

Perthes' Disease.—The reduction in density in Perthes' disease is due to breaking down of the center of ossification in the epiphysis of the femoral head. This leads to secondary flattening of the head and to alterations in the shape of acetabulum and neck. In a case of nine months' standing (D. B. Phemister, "Operation for Epiphysitis of the Head of the Femur [Perthes' Disease]: Findings and Result." *Archives of Surgery*, March, 1921, Vol. II, p.221), in which there were roentgenological evidences of bone destruction with flattening and cavity and sequestrum formation, operation with excision of a window from the cartilage of the head revealed a broken-down center filled with soft tissue, which was partly necrotic, and with various-sized sequestra. Microscopic examination of the contents showed granulation tissue with evidences of active absorption in the sequestra and cartilaginous wall

FIG. 28. Specimen excised from case in Figure 27. *a*—Eroded cortex showing through window.

FIG. 29. Section of cortex in case in Figure 27. *a*—Lining of fibroblasts producing bone absorption. *b*—Haversian canals dilated by invading process.

(Fig. 31). Bacteriologic examination and guinea-pig inoculation were negative for micro-organisms, but grossly and microscopically the process resembled a quiescent focus of localized pyogenic infection of the bone. It is possible that the negative bacteriologic findings are to be accounted for by the duration of the process, as it is not uncommon to obtain negative cultures in cases of localized osteomyelitis of several months' standing.

FIG. 30. Section of cyst wall in its thinnest portion. *a*—Fibrous layer of periosteum. *b*—Cambium layer. *c*—Thin layer of new bone. d—Cyst lining. Note perforation of bony layer at *e*, and extension of destructive cyst lining to fibrous layer of periosteum.

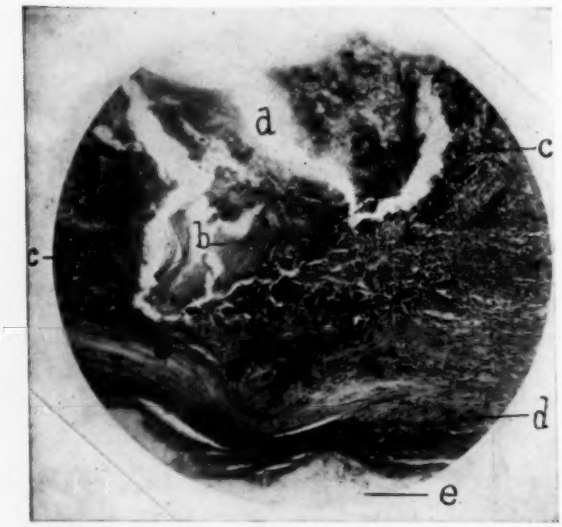

FIG. 31. Section through cartilaginous wall and inflammatory lining to cavity in epiphysis of head of femur in Perthes' disease. *a*—Necrotic contents. *b*—Sequestrum. *c*—Layer of granulations. *d*—Fibrous layer. *e*—Wall of cartilage.

Congenital Venous Aneurysm.—Figure 32 shows the roentgenologic appearance of the enlarged right upper extremity of an eighteen-year-old boy, produced by congenital venous aneurysm. The circular shadows, many of which are laminated, are produced by phleboliths that formed in the thrombi of the dilated vein. The humerus is little changed but the radius and ulna, in the region of which the varicosities are most marked, show extensive osteoporosis with longitudinal streaking and slight reduction in diameter. The cause of the osteoporosis is problematic. It is not due to disuse, as the function of the arm was not greatly impaired, and the humerus, which should be

FIG. 32. Congenital venous aneurysm of the upper extremity with marked osteoporosis of radius and ulna and circular shadows cast by phleboliths.

affected if this were the case, is practically free. It may be due to the venous congestion and consequent acidosis from an increase of the CO_2 content of the blood. This would augment the solubility of the lime salts and favor absorption. Similar osteoporosis has been observed in cases of enlargement of an extremity from congenital elephantiasis.

DISCUSSION

Answer to Dr. W. C. Hill. Gonorrheal infection of a joint produces rapid disappearance of the lime salts because of the marked loss of function resulting from the severe symptoms. The hyperemia and toxemia produced by the infection may possibly still further alter bone metabolism in such cases and exaggerate absorption of lime salts.

Answer to Dr. Geo. E. Pfahler. I believe Perthes' disease is an infectious process from the histologic examination of the excised tissue. The fact that cultures were negative does not exclude infection, because the process was of nine months' standing and it is not uncommon to obtain negative cultures of material removed from localized osteomyelitis several months after the onset.

Answer to Dr. H. K. Pancoast. In bone cyst the destruction occurs from within outward, and expansion of the bone is slight. It results from concomitant new bone formation on the part of the periosteum. The metacarpal cyst which I showed was an exception to this rule, in that considerable cortex was broken down and the cyst extended to the periosteum, partly dissecting the latter from the remaining bone and creating a large tumor. Pressure atrophy of bone in aneurysm is somewhat similar to that which occurs in tumors. Wherever bone is pressed upon, metaplasia of its connective tissue covering occurs, and osteoclasts are formed which lead to bone absorption in proportion to the amount of pressure.

Atrophy of bone following fracture is the result of disuse produced by the fracture, the immobilization for treatment, the muscle atrophy, joint stiffness, etc. Infection of the fracture increases the degree and duration of loss of function and consequently the amount of atrophy.

Answer to Dr. Percy Brown. I consider the atrophy in rheumatoid arthritis due to disuse.

Answer to Dr. W. R. Stewart. Roentgen signs are absent early in acute osteomyelitis, because bone destruction, being due to the action of infected tissue cells, does not occur to any appreciable extent until the acute destructive changes in the unossified tissue begin to subside and reparative changes set in. This requires from one to two weeks' time. It is difficult to state in a few words how to recognize the extent of dead bone in chronic osteomyelitis, and sometimes it cannot be done.[1] The greater density of dead bone, its irregular, sharp contour and the presence of a line of demarcation between the dead and living bone are the points of greatest assistance, but numerous factors, such as overlapping shadows of new and old bone and inflammatory changes in old or new bone, may lead to errors of diagnosis. It has been my experience that tumors that break through the cortex and lead to ossification extending into soft parts are malignant. However, benign processes, such as bone cyst, may completely erode the cortex and bulge beneath the periosteum without the occurrence of new bone formation about their periphery. In both of the cysts shown, old cortex had been completely eroded, in one very extensively, and in the other in two small places. I have never seen increase in the size and length of an extremity due to an angioma in the soft parts.

Answer to Dr. A. H. Pirie. A very small localized infection of bone, may in some instances leave an area of increased density, but this is not the case if an appreciable amount of bone destruction occurs.

Answer to Dr. L. R. Sante. Tuberculous osteomyelitis may affect the shaft of the bone, producing diffuse changes in the extremity difficult to differentiate from pyogenic osteomyelitis and syphilis by means of the *x*-ray.

Answer to Dr. B. C. Darling. I do not believe there is any distinction between osteomyelitis hemorrhagica of Barrie and central giant-celled tumors. There was no history of infection in the teeth or tonsils in this case of Perthes' disease.

[1]See "The Recognition of Dead Bone Based on Pathological and *X*-Ray Studies," D. B. Phemister, *Ann. Surg.*, October, 1920, lxxii, 467.

THE MAKING AND FILING OF RECORDS IN THE SECTION ON ROENTGENOLOGY IN THE MAYO CLINIC

By R. D. CARMAN, M.D.

Section on Roentgenology, Mayo Clinic

ROCHESTER, MINNESOTA

MANY inquiries from visitors to the Section on Roentgenology of the Clinic and letters requesting information concerning the method of keeping records in this department, led us to the conclusion that a description of the records might be of interest to a large number of the medical profession, more especially to those limiting their practice to roentgenology.

This method was evolved about eight years ago with the idea of covering every eventuality in order not only to learn the variations within normal limits but to learn the roentgen signs, both positive and negative. These records, accurately kept, together with a simple physiologic technique and abundant material controlled by operative and pathologic findings, added materially to our knowledge of both direct and indirect signs and have enabled us to bring our percentage of correct diagnoses to a very high degree of accuracy. Methods such as these have done much to place roentgenology at the head of the list of all methods of gastro-intestinal diagnosis. This is particularly true of the early lesions where the clinical data are usually indefinite. Too much stress connot be placed on the fact that the knowledge gained from studies of variations from the normal have been just as much a factor in this result as has been the study of the abnormal.

It has long been my conviction that progress in roentgen diagnosis lies along three very definite lines: ample material, full recording of all interpretations of this material, and careful comparison of those interpretations with surgical and pathologic findings. For many years in the Mayo clinic a complete record of the observations made on every patient sent for a gastro-intestinal study have been kept, irrespective of whether the findings were negative or positive. It is generally acknowledged that the fundamental requisite for a successful roentgenologist is a comprehensive knowledge of the normal. Our experience with these records has brought home the truth of this assertion. Equally important has been the inspection of the gross pathology presented at operation. The specimens have been followed to the laboratory and studied; comparisons have been made of the lesion as it appeared with the findings in the roentgenogram. Copies of the dictated notes on the operation have been made available to the department and these have been copied on to the statistical charts compiled from these records.

Record sheets similar to those used in the gastro-intestinal work have been made for the chest and the genito-urinary tract.

The test of any system is that it shall afford the maximum of accessibility to all information required, with the minimum expenditure of time and effort. This has been the aim in the evolution of this system. The record sheets all carry out this idea and are similar in many ways. They all bear the registration number, the name of the referring physician, the date, the name, age, and sex of the patient. Next follow the parts examined and a brief statement of the indication for examination. The line for the diagnosis is just above the printed key, in which the pathology is given a numerical code and the anatomy an alphabetical code unit. Thus, cancer of the stomach is written "5 B", duodenal ulcer "34 I". Incidentally the use of this code in the screen room makes it possible to discuss the screen findings without imparting any information to the patient. Sizes and degrees of density or involvement are expressed by numerals from 0 to 4, 4

representing the maximum. Code units of numerals or letters are used throughout the sheets and all units concerned in the study of a given case are underlined. The statistical charts are ruled and numbered to agree with the record sheets and in transferring the information to these charts the code units only are used (Fig. 1). The surgical findings in all cases in which operation is performed are copied on to the statistical charts. Records such as these always present the complete data on a given case in the same sequence and when transferred to the statistical charts they make a compact summary of roentgen signs in both the normal and the abnormal. Every patient admitted to the Clinic is given a registration card bearing a serial number (Fig. 2), the name and home address of the patient, the name of the chief of the section to which the patient is referred, the name of the examining physician, and the date of admission. This registration number is used on all the records of the patient throughout the Clinic, so that in time the record of an individual patient becomes complete in the general file of the Clinic and is there available for study and comparisons of the findings. Under a checking system these records are sent to various sections where they are wanted or may be assembled in the filing room for any given study.

All patients referred to the section of roentgenology from other sections are given a referring card (Fig. 3) with the name, registration number, the date, name of the referring physician and the section to which he is attached, the parts to be *x*-rayed, and a brief note of the information sought. The card is made in triplicate, the sheets being numbered 1, 2, and 3. Sheets 1 and 2 have carbon backs and the three separate sheets are filled out at one writing. The cards are enclosed in envelopes on which are printed and written all instructions for any necessary preliminary preparation and the time at which the patient is to come for examination.

The desk clerk asks for the registration card and as a check writes the registration number and age of the patient on the upper left hand corner, and notes whether the patient has been *x*-rayed in the section at any previous time. If so, the former record is taken from the files for comparison before the new report is made. If the patient has been *x*-rayed elsewhere recently an effort is made to determine the time elapsed and the amount of previous exposure in order to avoid any possible harm from overexposure.

The plate marker is made by the clerk who uses strips of 2 inch adhesive plaster cut in 2 inch lengths with the ends turned over to a depth of one-eighth of an inch. The date is put at the top of this oblong strip in quarter inch lead numerals and the registration number across the bottom in three-eighths inch lead numerals.

The marker is placed in the envelope with the referring card, all of which is sent with the patient to the technician.

The majority of our plates are marked in the upper left hand corner, the full set required for an individual case being marked at one exposure before the plates are exposed. They are protected while being marked with a sheet of lead soldered to galvanized iron, bound around the edges with adhesive tape and have an aperture just large enough to expose the marker (Fig. 4). An oblong of lead is attached by a brass clip over the marked area of each plate (Fig. 5). This is done to protect the mark during the exposure. Each technician carries a small aluminum plate to which his or her initials and the letters R and L in half-inch lead letters are fastened with adhesive. This is placed on the marker between the date and the registration number, thus marking every plate with the initials of the maker and indicating the right and left sides respectively. The initials of the operator are required in order to identify him with the case in the event of error, or necessary instruction in case of reexamination, or the need for special technique.

When the technicians have finished making the plates on any one patient the referring card and the marker are returned to the clerk. The markers are remade with new

registration numbers until their adhesive quality becomes so dull as to make them unfit for further use. The referring cards are then placed in racks beside the desk. Two of these racks have two rows of thirty pockets each for cards for the chest and the gastro-intestinal canal. A third rack of the same capacity has one row for cards for bones and one for cards of the urinary tract.

When the plates are dry they are brought to the plate room and sorted, the racks are brought in from the desk, and the plates are stacked with the referring card in front of each set, ready for interpretation.

The plates are filed in different colored envelopes according to the findings. Those with positive findings are filed in buff envelopes, some types with positive findings such as "heart enlarged," "phleboliths," etc., in blue envelopes, and the negative findings in yellow envelopes. A rack, mounted on rubber-tired wheels, with spaces for three sizes of each color envelope, is brought within easy reach of the one making the interpretations. The interpretations are dictated and typed, the plates are handed to the plate-room clerks with the envelopes in which they are to be filed, the same clerk receiving the referring card from the stenographer.

The number three sheet of the referring card is pasted on the upper right-hand corner of the envelope, the number one sheet is torn off and placed in the compartment bearing the number of the desk to which it will be sent later, and the number two sheet is placed in a compartment marked for the clerk in charge of records.

The plates are filed in numerical

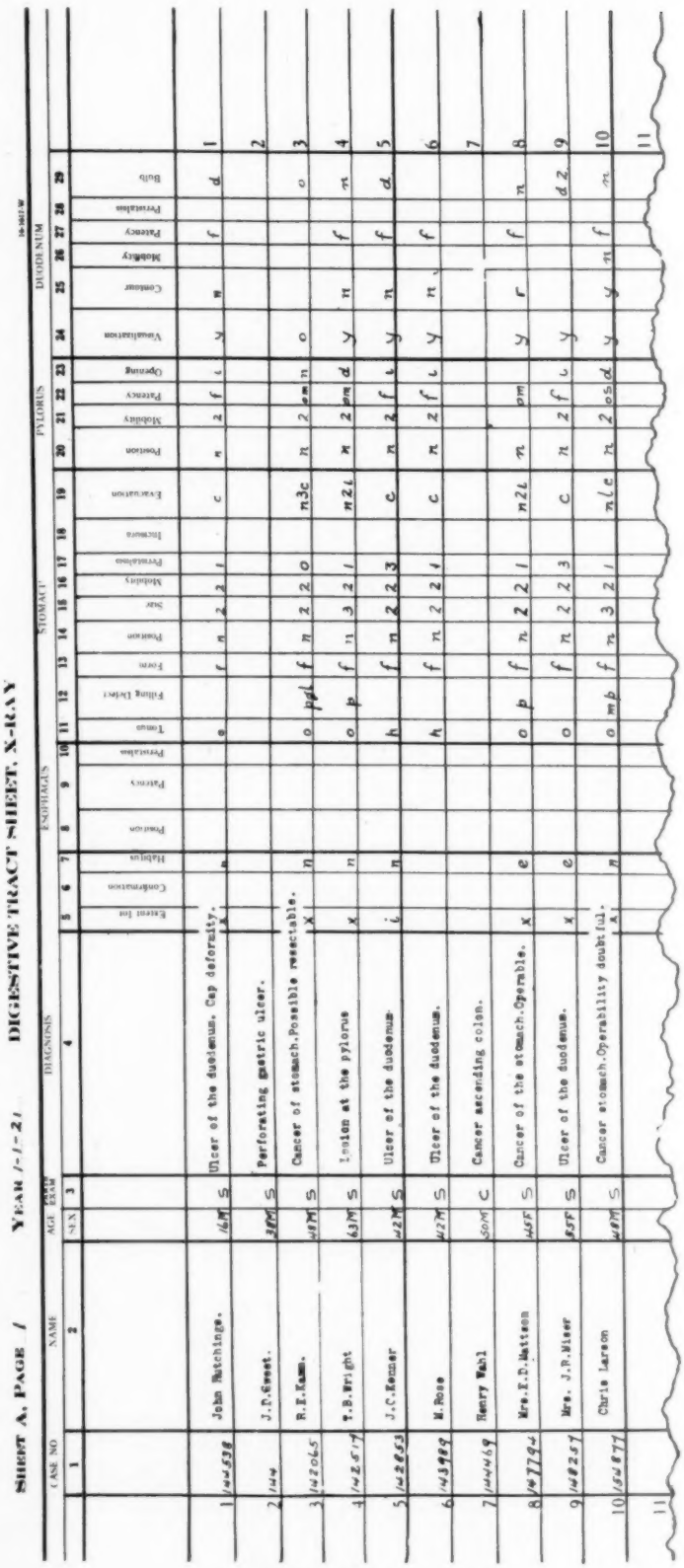

FIG. 1. Recapitulation chart.

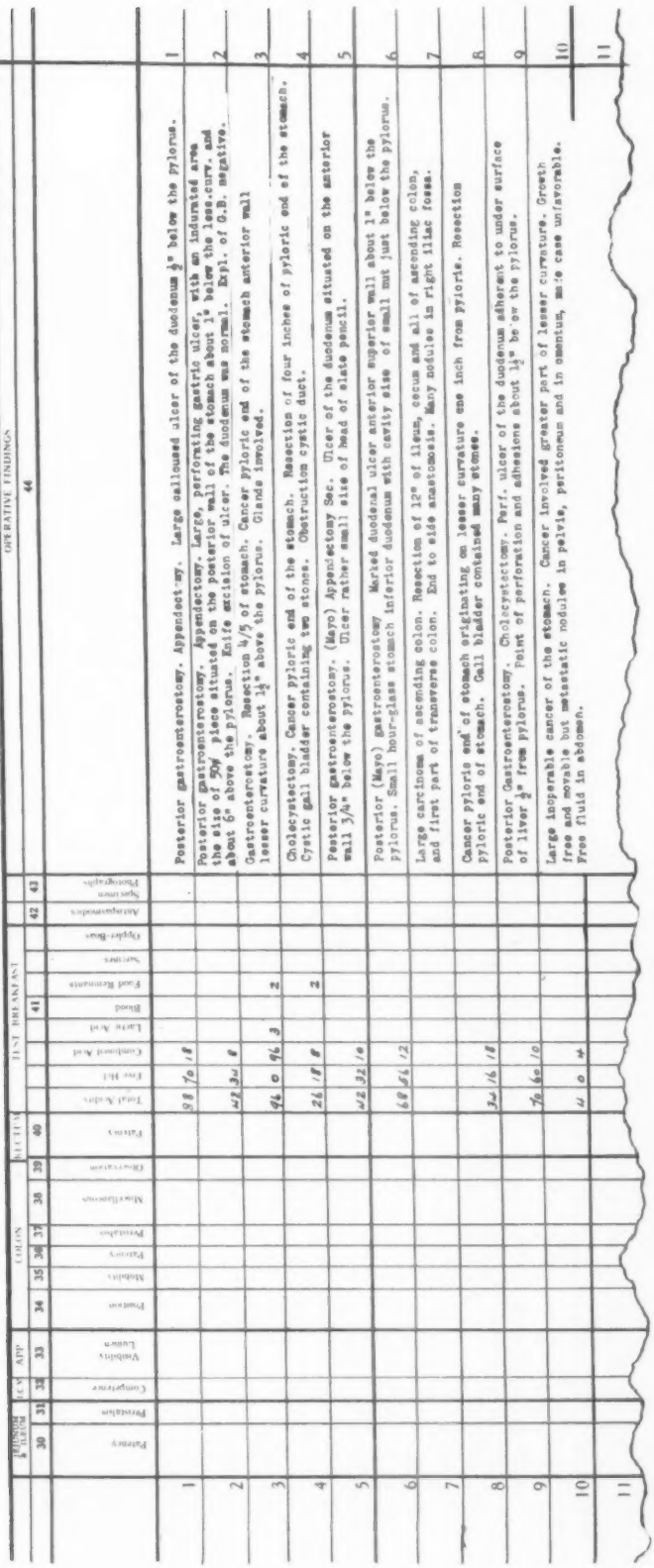
DIGESTIVE TRACT SHEET. X-RAY
SHEET B. PAGE /
YEAR 1-1-21
OPERATIVE FINDINGS
TEST BREAKFAST
Posterior gastroenterostomy. Appendectomy. Large callouused ulcer of the duodenum ½" below the pylorus.
Posterior gastroenterostomy. Appendectomy. Large, perforating gastric ulcer, with an indurated area the size of 50¢ piece situated on the posterior wall of the stomach about 1" below the less.curv. and about 6" above the pylorus. Knife excision of ulcer. The duodenum was normal. Expl. of G.B. negative.
Gastroenterostomy. Resection 4/5 of stomach. Cancer pyloric end of the stomach anterior wall lesser curvature about 1½" above the pylorus. Glands involved.
Cholecystectomy. Cancer pyloric end of the stomach. Resection of four inches of pyloric end of the stomach. Cystic gall bladder containing two stones. Obstruction cystic duct.
Posterior gastroenterostomy. (Mayo) Appendectomy Sec. Ulcer of the duodenum situated on the anterior wall 3/4" below the pylorus. Ulcer rather small size of head of slate pencil.
Posterior (Mayo) gastroenterostomy Marked duodenal ulcer anterior superior wall about 1" below the pylorus. Small hour-glass stomach inferior duodenum with cavity size of small nut just below the pylorus.
Large carcinoma of ascending colon. Resection of 12" of ileum, cecum and all of ascending colon, and first part of transverse colon. End to side anastomosis. Many nodules in right iliac fossa.
Cancer pyloric end of stomach originating on lesser curvature one inch from pylorus. Resection pyloric end of stomach. Gall bladder contained many stones.
Posterior Gastroenterostomy. Cholecystectomy. Perf. ulcer of the duodenum adherent to under surface of liver ½" from pylorus. Point of perforation and adhesions about 1½" below the pylorus.
Large inoperable cancer of the stomach. Cancer involved greater part of lesser curvature. Growth free and movable but metastatic nodules in pelvis, peritoneum and in omentus, case unfavorable. Free fluid in abdomen.

FIG. 1. Recapitulation chart.

order, the positive at one end of the plate-room and the negative at the other. The 14 inch by 17 inch plates are in one series of compartments and all other sizes in another series. The envelopes are placed on edge with the labeled upper right-hand corner in front and one compartment is allowed for every one hundred registration numbers in each size. This arrangement enables us to keep plates with positive findings in the file room for about six months. At the end of this period they are culled of all that suggests no further clinical interest and transferred to permanent files in another part of the building. All plates in blue envelopes are discarded at this time. Negative plates (in yellow envelopes) are discarded at the end of thirty days.

Plates showing conditions of unusual interest or findings that give them a value for teaching purposes are sent for reduction on 5 inch by 7 inch films from which lantern slides are made later. When reductions and lantern slides have been made the original plates are discarded.

The reductions are filed in numerical order in envelopes on which the registration number is stamped and the name of the patient and clinical or surgical findings are typed.

The lantern slides are filed in envelopes similarly marked, but instead of being in numerical order they are grouped according to pathologic interest.

We have found that it adds to the value of the lantern-slide file to cross index by carrying cards of the same size as the envelope in such cases as syphilis of the stomach, with hour-glass contrac-

tions. In such cases the envelope is carried under syphilis of the stomach, while the card bearing the same number and information is carried under hour-glass stomach. This obviates the necessity of any index for the reductions or the lantern slides.

We use the ordinary unit-type filing cabinet, the reductions in files with drawers for 8 inch by 5 inch cards, and the lantern slides in drawers for 5 inch by 3 inch cards. The No. 1 sheet of the referring card is returned to the physician when the interpretation has been made. The No. 2 sheet is given to the clerk in charge of records and department records are made from it. The negative cases are entered on a sheet headed "———Sheet,

Please Keep This Card

and if you have occasion to write, be sure to give this card number and doctor's name, also date when you were here.

PLEASE DO NOT ASK TO BE FAVORED OUT OF TURN.

315992

Head of Section, Doctor Brown

Examining Physician, Doctor Black

Date 1.20.21

Name John Harold Prince

Post Office Belle View Iowa.

READ INFORMATION ON BACK OF THIS CARD 4-406-W

FIG. 2. Registration card.

X RAY REFERRING CARD

Chas. Bell 342570

X RAY REFERRING CARD

Chas. Bell 342570

X RAY REFERRING CARD

Chas. Bell 342570

Date 12.7.20 Referred by Dr. Beckman Residence

Part to be exposed Left wrist and right knee

Arthritis

Report Marked destructive arthritis left wrist, phalangeal joints and right knee

FIG. 3. Referring card.

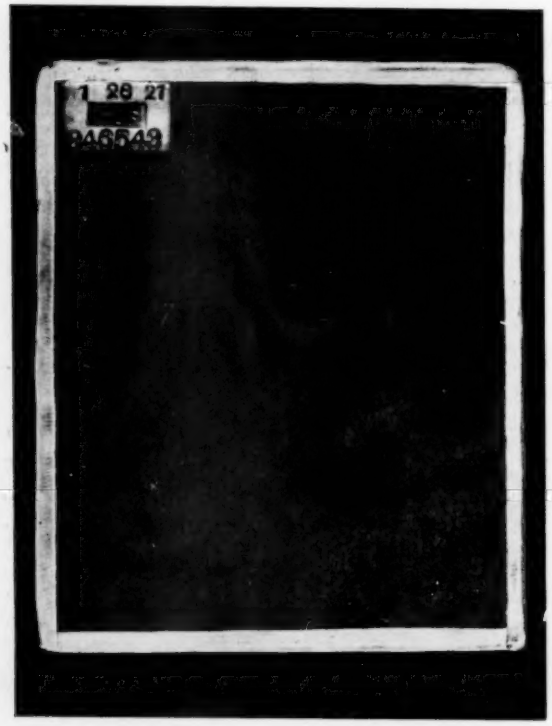

FIG. 4. Lead plate shield with plate marker in place.

FIG. 5. Brass clip to protect plate marker during exposure.

346000-347000 CHEST SHEET, X-RAY
Mayo Clinic

Case Number Negative Findings

1/11/21 346006M	1/15/21 346069M	1/18/21 346625M	1/19/21 346501M	1/20/21 346996M
346045M	346101M	346604M	346696M	346896M
346019M	346122M	346595M	346698M	346864M
346016S	346186M	346582M	346774M	346960M
346012M	346191M	346578S	346755S	346929M
346009M	346271M	346562M	346726M	346840M
346120M	346279M	346537S	346716S	346817M
1/12/21 346080M	346285M	346495M	346714S	346799M
346059M	346329M	346420M	346690S	
346027M	1/16/21 346577S	346228M	346683M	
346000M	346521S	346202M	346677M	
1/13/21 346183M	346509S	346188S	346673M	
346148M	346503S	346724M	346667M	
346172M	346483S	346680M	346653M	
346168M	346480S	346675M	346155M	
346110M	346466S	346652M	1/20/21 346912S	

FIG. 6. History sheet on which are recorded negative findings.

HISTORY SHEET, X-RAY
MAYO CLINIC

NO. PLATES ..... SIZE (8, 10, 11, 14) .....

Case No. A 347038 X-Ray No. ..... Phy. Moore Date 1-21-21

NAME P. N. Miller ..... ADDRESS ..... SEX (m. f.) AGE 64

INDICATIONS FOR EXAMINATION .....

ADDITIONAL RADIOGRAMS .....

PARTS EXAMINED Left knee and tibia.

DIAGNOSIS Old fracture of the patella with firm union. Marked destructive arthritis of the knee. Areas of calcification in soft tissues posteriorly. M.

SUBSEQUENT EXAMINATIONS .....

FIG. 7. History sheet, *x*-ray, for recording lesions of the osseous system.

x-ray, Case number, Negative findings" (Fig. 6). The blank is filled in to correspond with the headings of the different department record sheets. Separate sheets are used for "Digestive tract," "Chest," "Bone," "Urinary tract," etc. One sheet is headed for each thousand registration numbers and the date, registration number, and initials of the physician making the interpretation are entered for each negative case. All the sheets for each 5,000 registration numbers are kept in slip covers on which is stamped the open-

CHEST SHEET, X-RAY

1. CASE NO. A.. ..... 2. X-RAY NO.....Phy..... .....Date.....
3. NAME.....Sex, (m. f.).. .....Age .....Size of Patient 1 2 3..... ....
4. INDICATION FOR EXAMINATION — ADDITIONAL RADIOGRAPHS
5. CONFIRMATION Confirmed by.....Contradicted by..... .....Bacteriologic.....Operation..... .....P. M.

KEY—?Possible pProbable dDefinite rRight lLeft uUpper mMiddle oLower aApex hHilus bBase fAnterior kPosterior Size or Degree 0, 1, 2, 3

CHEST

6. **Expansion**—eEqual nUnequal xDiminished R L 7. **Density** R 0 1 2 3 gGeneral cLocal u m o / L 0 1 2 3 gGeneral cLocal u m o

PLEURA

8. **Density** R 0 1 2 3 gGeneral cLocal u m o / L 0 1 2 3 gGeneral cLocal u m o 9. **nRetraction** R L

LUNG

10. **Bronchus—Density** R 0 1 2 3 / L 0 1 2 3 11. **Fibrillation** R 0 1 2 3 u m o / L 0 1 2 3 u m o

12. **Consolidation** R 1 2 3 gGeneral cLocal u m o xSingle yMultiple zSize 1 2 3 / L 1 2 3 gGeneral cLocal u m o xSingle yMultiple zSize 1 2 3

13. **Congestion** R 1 2 3 xActive yPassive u m o / L 1 2 3 xActive yPassive u m o 14. **Glands** R 1 2 3 xSingle yMultiple / L 1 2 3 xSingle yMultiple

15. **Cavity Size** R 1 2 3 xSingle yMultiple u m o / L 1 2 3 xSingle yMultiple u m o

HEART

16. **Size**—0 1 2 3 xAuricular enlargement yVentricular enlargement

17. **Position**—nNormal qTransposed gDisplaced rRight 1 2 3 lLeft 1 2 3 eUp 1 2 3 wDown 1 2 3 vVertical xTransverse

18. **Pericardial Sac**—zSize 0 1 2 3 xDensity 0 1 2 3 **Outline**—yRegular zIrregular eCardio-hepatic angle 0 1 2 3

AORTA

19. **Size**—0 1 2 3 gGeneral cAscending nArch eDescending xFusiform yPulsatile zExpansile

20. **Position**—nNormal gDisplaced 1 2 3 rRight lLeft fAnteriorly kPosteriorly

21. **Retrocardiac Space Diminished** 1 2 3 22. **Esophageal Obstruction** 1 2 ?

MEDIASTINUM

23. **Density**—gDegree 0 1 2 3 nSize 1 2 3 Location u m o f k wCircumscribed xDiffuse yRegular zIrregular

DIAPHRAGM

24. **Excursion** R nNormal iIncreased yDiminished zAbsent / L nNormal iIncreased yDiminished zAbsent

25. **Position** R nNormal yHigh zLow / L nNormal yHigh zLow

26. **Contour**—yRegular zIrregular wBroken

7-704-W

KEY—?Possible pProbable dDefinite rRight lLeft uUpper mMiddle oLower aApex hHilus bBase fAnterior kPosterior Size or Degree 0, 1, 2, 3

LUNG

28. **Abscess**.....
29. **Anthracosis**.....
30. **Asthma**.....
31. **Atele**.....
32. **Bronchiectasis**.....
33. **Bronchitis**.....
34. **Congestion**.....
35. **Consolidation**.....
36. **Emphysema**.....
37. **Fibrosis**.....
38. **Foreign Body**.....
    wBronchus yTrachea
    xLung zEsophagus
39. **Malignancy**.....
    yPrimary.....
    zMetastatic.....
40. **Syphilis**.....
    yInfiltration.....
    zGummata.....
41. **Tuberculosis**.....
    cCavity.....
    jDiffuse.....
    vEarly.....
    wHealed (Calcified)...
    xInfiltration.....
    yMiliary.....
    zOld.....
42. **Tumor**.....
    vBenign.....
    wMalignant.....
    xCystic.....
    yPrimary.....
    zMetastatic.....

PLEURA

43. **Fistula** (Thoracotomy)
44. **Fluid in**.....
45. **Foreign Body**.....
46. **Pleuritis**.....
    xInterlobular.....
    yPeripheral (thick'n'd)
    zTubercular.....
47. **Tumor**.....

MEDIASTINUM

48. **Abscess**.....
49. **Adenitis**.....
    wInflammatory.....
    xHodgkins' Disease..
    yMalignant.....
    zTubercular.....
50. **Aneurysm**.....
    cAscending.....
    eArch.....
    gDescending.....
    iInnominate.....
    jSubclavian.....
    qCarotid.....
51. **Aortic Dilatation**.....
    xAscending.....
    yArch.....
    zDescending.....
52. **Goiter, Substernal**..
53. **Goiter, Superficial**..
54. **Mediastinitis**.....
55. **Thymus**.....
    yEnlarged.....
    zPersistent.....
56. **Trachea**.....
    yDisplaced.....
57. **Tumor**.....
    xBenign.....
    yMalignant.....
    zCystic.....

HEART

58. **Displacement**, R L
59. **Enlargement**.....
60. **Pericardial Adhesions**.....
61. **Pericardial Fluid**...
62. **Transposed**.....
63. **Transverse**.....
64. **Vertical**.....

NEGATIVE—

DIAGNOSIS— *T.B. both uppers, marked fibrosis in the left upper. S.*

FIG. 8. Chest sheet, *x*-ray.

ing and closing number of the series contained. The negative sheets are filed in separate drawers in the department record file.

The department records are made out on the sheets described earlier, four different forms being used, headed respectively "History sheet, *x*-ray" (Fig. 7), "Chest sheet, *x*-ray" (Fig. 8), "Urinary tract sheet, *x*-ray" (Fig. 9) and "Digestive tract sheet, *x*-ray" (Fig.10).

In the gastro-intestinal examinations a "fluoroscopic sheet, *x*-ray" (Fig. 11) is

URINARY TRACT SHEET, X-RAY

MAYO CLINIC

1. CASE NO. A 246553 2. X-RAY NO. ..... PHY. Moore DATE 1-18-21 NO. PLATES ... SIZE (8, 10, 11, 14) ...
3. NAME Thomas Ash Sex, (m. f.) ..... Age 35 Address .....
4. LAST PREVIOUS RAYING OF PATIENT ..... 5. ADDITIONAL RADIOGRAPHS .....
6. PARTS EXAMINED—kKidney uUreter bBladder sProstate uUrethra aAll
7. CLINICAL DIAGNOSIS (or data) .....
?Possible pProbable dDefinite
8. DIAGNOSIS 1....Anomaly..... 2....Cyst..... 3....Displacement..... 4....Diverticulum.....
5....Foreign body..... 6....Hydronephrosis..... 7....Hydroureter..... 8....Indeterminate.....
9....Normal..... 10....Obstruction..... 11....Pyelitis..... 12....Pyonephrosis.....
13....Pyoureter..... 14....Stone..... 15....Tuberculosis..... 16....Tumor.....iInt....eExt...
kKidney uUreter bBladder sProstate uUrethra
9. EXTENT OF INTEREST oOrdinary iInteresting xExtraordinary
Findings: Phleboliths on both sides. Small shadow over left kidney, Probably ret. stone. NL
write in full as reported to clinician
.....
.....
10. AGREEMENT AND CONFIRMATION aAgrees with clinical dDisagrees pPartially confirmed cConfirmed nContradicted by tTreatment results
oOperative Findings mPost Mortem 1 Small 2 Medium 3 Large
PREPARATION OF PATIENT—gGood fFair pPoor sSize of Patient (1, 2, 3) .....

RADIOGRAPHY

RIGHT KIDNEY
11. VISIBILITY OF OUTLINE vVisible iInvisible
12. SIZE (1, 2, 3) .....Shape. nNormal iIrregular
13. POSITION nNormal dDisplaced to rRight lLeft oRotated yLow Lying, degree (1, 2, 3) .....pPelvic
14. SHADOWS (Suspicious) iSingle mMultiple
15. SHADOWS (Extrarenal) iSingle mMultiple Due to bBowel Contents sSkin Conditions aAtheroma pPhleboliths eExostosis cCalcified Areas or Glands rCalcified Costal Cart gGallstone tFract. Transverse Process

LEFT KIDNEY
16. VISIBILITY OF OUTLINE vVisible iInvisible
17. SIZE (1, 2, 3) .....Shape. nNormal iIrregular
18. POSITION nNormal dDisplaced to rRight lLeft oRotated yLow Lying, degree (1, 2, 3) .....pPelvic
19. SHADOWS (Suspicious) iSingle mMultiple
20. SHADOWS (Extrarenal) iSingle mMultiple Due to bBowel Contents sSkin Conditions aAtheroma pPhleboliths eExostosis cCalcified Areas or Glands rCalcified Costal Cart gGallstone tFract Transverse Process

RIGHT URETER
21. SHADOWS aSuspicious eExtraureteral

LEFT URETER
22. SHADOWS aSuspicious eExtraureteral

BLADDER
23. SHADOWS aSuspicious eExtravescial

PYELOGRAPHY

DATE .....

RIGHT KIDNEY
24. VISIBILITY OF OUTLINE vVisible iInvisible
25. SIZE (1, 2, 3) .....Shape. nNormal iIrregular
26. POSITION nNormal dDisplaced to rRight lLeft oRotated yLow Lying, degree (1, 2, 3) .....pPelvic
27. SHADOWS (Intrarenal) pPelvic kCortical iSingle mMultiple Size (1, 2, 3) .....vVarious Due to sStone tCalcified Areas yCyst uTumor, intrinsic cCaseous Areas (Tuberculosis)
28. SHADOWS (Extrarenal) iSingle mMultiple Due to bBowel Contents sSkin Conditions aAtheroma pPhleboliths eExostosis bCalcified Areas or Glands rCalcified Costal Cart gGallstone tFractured Transv. Process
29. HYDRONEPHROSIS Size (1, 2, 3) .....fInfectious oObstructive
30. PYONEPHROSIS Size (1, 2, 3) .....tTubercular nNon-Tubercular
31. PYELITIS sSlight mMarked
32. ANOMALIES fFused hHorseshoe sSolitary rReduplication pelvis

LEFT KIDNEY
33. VISIBILITY OF OUTLINE vVisible iInvisible
34. SIZE (1, 2, 3) .....Shape. nNormal iIrregular
35. POSITION nNormal dDisplaced to rRight lLeft oRotated yLow Lying, degree (1, 2, 3) .....pPelvic
36. SHADOWS (Intrarenal) pPelvic kCortical iSingle mMultiple Size (1, 2, 3) .....vVarious Due to sStone tCalcified Areas yCyst uTumor, intrinsic cCaseous Areas (Tuberculosis)
37. SHADOWS (Extrarenal) iSingle mMultiple Due to bBowel Contents sSkin Conditions aAtheroma pPhleboliths eExostosis cCalcified Areas or Glands rCalcified Costal Cart gGallstone tFractured Transv. Process
38. HYDRONEPHROSIS Size (1, 2, 3) .....fInfectious oObstructive
39. PYONEPHROSIS Size (1, 2, 3) .....tTubercular nNon-Tubercular
40. PYELITIS sSlight mMarked
41. ANOMALIES fFused hHorseshoe sSolitary rReduplication pelvis

10-1007 W

FIG. 9. Urinary tract sheet, *x*-ray (*front*).

RIGHT URETER

42. **SHAPE** nNormal tTortuous
43. **POSITION** nNormal dDisplaced to rRight lLeft
44. **PATENCY** fFree dDilated locally at..... {1 2 3} aThroughout oObstructed at..... {1 2 3} by sStone rStricture kKink tTumor
45. **SHADOWS** (Intraureteral) **sStone** gSingle tMultiple **Size** lLarge mMedium aSmall vVarious oLocation..... {1 2 3}
Shape rRegular iIrregular
46. **SHADOWS** (Extraureteral) due to bBowel Contents sSkin Conditions aAtheroma pPhleboliths eExostosis
cCalcified Areas or Glands rCalcified Costal Cart tFract. Transv. Proc.
47. **ANOMALIES** rReduplication cComplete pPartial, Location..... {1 2 3} dDiverticulum Location..... {1 2 3}

LEFT URETER

48. **SHAPE** nNormal tTortuous
49. **POSITION** nNormal dDisplaced to rRight lLeft
50. **PATENCY** fFree dDilated locally at..... {1 2 3} aThroughout oObstructed at..... {1 2 3} by sStone rStricture kKink tTumor
51. **SHADOWS** (Intraureteral) **sStone** gSingle tMultiple **Size** lLarge mMedium aSmall vVarious oLocation..... {1 2 3}
Shape rRegular iIrregular
52. **SHADOWS** (Extraureteral) due to bBowel Contents sSkin Conditions aAtheroma pPhleboliths eExostosis
cCalcified Areas or Glands rCalcified Costal Cart tFract. Transv. Proc.
53. **ANOMALIES** rReduplication cComplete pPartial, Location..... {1 2 3} dDiverticulum Location..... {1 2 3}

BLADDER

54. **SIZE** dDilated cContracted
55. **SHAPE** rRegular iIrregular
56. **POSITION** nNormal dDisplaced rRight lLeft
57. **SHADOWS** (Intravesical) **sStone** gSingle tMultiple **Size** lLarge mMedium aSmall fForeign Body dDiverticulum
uTumor (intrinsic) pPhosphatic deposit in wall

PROSTATE

58. sStone iSingle mMultiple hHypertrophy tTumor

URETHRA

59. sStone fForeign Body

REMARKS·

FIG. 9. Urinary tract sheet, *x*-ray (*back*).

added to the data sent in with the patient and in all re-ray cases the former records of the patient are also sent in. The screen findings are recorded on the fluoroscopic sheet, the words and numbers concerned are underlined, and the diagnostic opinion is recorded in the blank rectangular space. All these findings are compared with the plate interpretation, The diagnosis is dictated and typed on the referring card and the procedure from this point is the same as heretofore described.

The positive records are all filed together in numerical order; if more than one record exists on one patient they are clipped together. Guide cards divide the records of every five hundred registration numbers.

The findings are indexed and cross indexed, the main divisions anatomic and the subdivisions pathologic. Different colored guide charts are used in the divisions and the subdivisions, one color denoting anatomic and another pathologic divisions or subdivisions.

If in interpreting plates we find some that promise unusual interest the registration number is noted and later these plates are put into the lantern slide compartment for the investigation of the history of the patient and the making of lantern slides if they are deemed sufficiently interesting.

Copies of the dictated notes on all necropsies are sent to the section and the plates on all are brought to the lantern slide compartment for investigation and study.

In the working out of this system we have had valuable suggestions from visitors to the Clinic and from clinics we have visited. The system has proved satisfactory in the Section of Roentgenology of the Mayo Clinic in recording the findings in more than 57,000 examinations made in 1920. The simplicity of the system makes it applicable to departments in hospitals or clinics or even a large private practice.

DIGESTIVE TRACT SHEET, X-RAY.
MAYO CLINIC

N. P.

1. Case No. A 154877 Phy Parker C Logan) Date 1-1-21 NO. PLATE SIZE 8, 10, 11, 14
2. NAME Chris Larson Sex, M. F. M Age 48 Address New York

3. PART EXAMINED—eEsophagus sStomach dDuodenum iSmall Intestine cColon rRectum gGall-bladder hStasis aAll

Clinical Data

NOTE—Under column 4 (Diagnosis) numbers 1 to 38 represent lesions, and the letters A to U, anatomical parts involved. A diagnosis would be recorded thus: Cancer of the stomach, "5 B"; Ulcer of the duodenum "34 I"; etc.

4. DIAGNOSIS

(1)Abscess (2)Adhesion (3)Anomaly (4)Atony (5)Cancer (6)Dilatation (7)Displacement (8)Diverticulum
(9)Enteroptosis (10)Fistula (11)Foreign Body (12)Hernia diaphr. (13)Hirschsprung's Dis. (14)Hour-Glass
(15)Incompetence (16)Indeterminate (17)Jackson's M. (18)Kink (19)Negative (20)Non-Rotation
(21)Normal (22)Obstruction (23)Ptosis (24)Redundancy (25)Spasm (26)Spasticity (27)Stasis
(28)Stenosis (29)Stricture (30)Syphilis (31)Transposition (32)Tuberculosis (33)Tumor (34)Ulcer
(35)Cardiospasm (36)Gall-stones (37)Filling Defect (38)Diverticulitis (39)Chr. Ulc. Colitis
(A)Esophagus (B)Stomach (C)Cardia (D)Media (E)Pars pylor. (F)Pylorus
(G)Greater curv. (H)Lesser curv. (I)Duodenum (J)Jejunum (K)Ileum (L)Ileo-cecal Valve
(M)Colon (N)Cecum (O)Ascending Colon (P)Hepatic Flexure (Q)Transverse Colon
(R)Splenic Flexure (S)Descending Colon (T)Sigmoid Flexure (U)Rectum

FINDINGS Cancer of the stomach. Operability doubtful
(as reported, write in full)

5. **EXTENT OF INTEREST**—oOrdinary iInteresting xExtraordinary
6. **CONFIRMATION**—Partially confirmed by cConfirmed by nContradicted by tTreatment results oOperative Findings mPost-Mortem
7. **HABITUS**—nNormal eEnteroptotic

ESOPHAGUS
8. **POSITION**—nNormal dDisplaced rRt. lLt. fFwd. bBack
9. **PATENCY**—fFree dDilated uUpper mMiddle wLower oObstructed degree (1 2 3 4)....aSymmetrical yIrregular uUpper mMid. wLower xDiverticulum, apparent size (1 2 3 4)....aAnt. pPost. rRight lLeft At level of....vertebra (0. Not Seen, 1. Normal, 2. Active 3. Vigorous)
10. **PERISTALSIS**—(0 1 2 3)....tAntiperistalsis

STOMACH
11. **TONUS**—hHypertonic oOrthotonic yHypotonic
12. **FILLING DEFECTS**—cCard mMed pPyl. gGreater curv. lLesser curv. aAnterior wall sPosterior wall tCentral wNiche kAcc. Pocket
13. **FORM**—fFish-hook sSteer-horn hHour-glass oOrganic pSpasmodic dDeformed
14. **POSITION**—nNormal vVertical oOblique tTransverse Displaced rRt. lLt. uUp dDown xTransposition xHernia (diaph.) (1. Small 2. Medium, 3. Large, 4. Very Large.)
15. **SIZE**—(1 2 3 4).... (0. Fixed, 1. Slightly Mobile, 2. Mobile.)
16. **MOBILITY**—(0 1 2).... (0. Not Seen, 1. Normal, 2. Active, 3. Hyperperistalsis.)
17. **PERISTALSIS**—(0 1 2 3)....tAntiperistalsis yIrregular
18. **INCISURA**—cCard. mMed. pPyl. nNarrow bBroad dDeep sShallow =Double †Multiple uPseudo tTransient yCorresponds to pain pt
19. **EVACUATION**—(c)Complete after six hrs. nIncomplete after six hrs. Size of Residue (1 2 3 4)....hHead....

PYLORUS
20. **POSITION**—nNorm. Displaced rRt. lLt. uUp. oDown. (0. Fixed, 1 Slightly Mobile, 2. Mobile.)
21. **MOBILITY**—(0 1 2)....
22. **PATENCY**—fFree gGaping oObstructed sSlightly mMkd.
23. **OPENING**—iImmediate dDelayed nNot Seen

DUODENUM
24. **VISUALIZATION**—yVisualized oNot Visualized
25. **CONTOUR**—rRegular yIrregular dDiverticulum bBulb 2Second Portion 3Third Portion
26. **EVACUATION**—nNormal rRapid tSlow 6 Hour Residue (1 2 3 4)....
27. **PATENCY**—fFree dDilated oObstructed sSlightly mMkd. (0. Not Seen, 1. Normal, 2. Active, 3. Vigorous)
28. **PERISTALSIS**—(0 1 2 3)....
29. **BULB**—nRegular dDeformed Size..(1 2 3 4)....oNot Seen

10-1000 W

FIG. 10. Digestive tract sheet, *x*-ray (*front*).

JEJUNUM AND ILEUM 30. **PATENCY**—nNorm dDilated.....oObstructed.....kKink aAdhesion tTumor bForeign Body fFistula vDiverticulum
sStasis after.....hrs.

31. **PERISTALSIS**—nNorm rRapid sSlow fFrequent iInfrequent

ILEO-CECAL VALVE 32. **COMPETENCE**—iIncompetent oObstructed

APPENDIX 33. **VISIBILITY**—vVisible dTender aFixed bRetrocecal
LUMEN—nNorm wWide rNarrow tTortuous cCurled kKinked fFistula
(To indicate part of bowel affected enter on the dotted line after the item the following letters)
(C, A, H F, T, S F, D. S)

COLON 34. **POSITION**—nNormal.....dDisplaced.....rRt.....lLt.....uUp.....wDown.....xNon-rotation.....xTransposition

35. **MOBILITY**—0 Fixed.....1 Slightly Mobile.....2 Mobile.....

36. **PATENCY**—nNormal lDilated.....oObstructed.....

37. **PERISTALSIS**—aAntiperistalsis.....nNormal.....oNot Seen.....

38. **MISCELLANEOUS**—vDiverticulitis.....uFistula.....jAdhesions.....rRedundancy.....xFilling Defect.....
aAnomaly.....bForeign Body.....kStasis.....cColitis.....After hrs.....

39. **OBSERVATION**—after *jInjection gIngestion

RECTUM 40. **PATENCY**—fFree dDilated oObstructed iImpaction tTumor bForeign Body aAdhesions fFistula

41. **TEST BREAKFAST**—Chemical: tTotal Acidity..... fFree Hcl.....cCombined Acidity.....lLactic Acid.....Microscopic:
bBlood.....rFood Remnants.....sSarcinae.....yYeast Cells.....

42. **ANTISPASMODIC GIVEN**—bBelladonna aAtropine pPapaverine

43. **SPECIMEN PHOTOGRAPHS**—yYes nNo

44. **OPERATIVE FINDINGS:**

FIG. 10. Digestive tract sheet, *x*-ray (*back*).

FLUOROSCOPIC SHEET
MAYO CLINIC

10-1008-W

Case No. A..... **Sex**..... **Age**..... **Date**.....

Name.....

Chemical { Total Acidity / Free HCl. / Comb. Acids / Lactic Acid

Microscopic { Food Remnants / Oppler-Boas / Yeast / Sarcines

Habitus Hypersthenic Asthenic Sthenic

Residue 0. 1. 2. 3. 4.

Head L. C. H. F. T. C. S. F. D. S.

Peristalsis Nor. Active Vigorous Hyper. Not Seen

Bulb Seen Regular Irregular Not Seen

Duod. Visualized Immediately Delayed Not Seen

Antrum Seen Regular Irregular Not Seen

Mobility Free Slightly Fixed Fixed

Tender Point L. C. Doud. G. B. McB. Epig.

Filling Defects Cardia Media. Pylorica GC. LC.

Niche

Accessory Pocket

Incisura Cardia Media. Pylorica Transient

Diverticulum

Hour-Glass Stomach Organic Spasmodic Intermittent

Operations:

4

N. P.

34 I

C

FIG. 11. Fluoroscopic sheet.

CONGENITAL NON-ROTATION OF THE STOMACH*

By L. C. KINNEY, M.D.

SAN DIEGO, CALIFORNIA

CONGENITAL anomalies in the development or position of the stomach are exceedingly rare. It is relatively common to find anomalies in the ileocecal region, such as pericolic membrane or unusual position and attachment of the ileum, cecum or appendix. All stages of the normal embryonic rotation and descent of the cecum are found arrested and present in the adult tract. The appendix and cecum may remain fixed at the hepatic margin as a permanent position, or the tip of the appendix may be caught in the liver margin and be stretched out posteriorly the entire length of the ascending colon through the descent of the cecum. Failure of rotation is frequently seen in the presence of an ileum that enters the cecum posteriorly or externally instead of in its normal position.

On the other hand failure of descent or rotation of the stomach is exceptional. According to the classification of Nau, this condition must be termed an "incomplete embryonic diaphragmatic hernia." Paillard at the University of Paris, in 1903, reported only sixteen such cases in literature and only two on the right side. Griffin of Rochester, in his exhaustive study of 1912, reported only one case of embryonic hernia of the stomach on the right side. I have been unable to find another case in going over the literature since 1912.

The case presented herewith exhibits two types of non-rotation and failure of descent in the gastro-intestinal tract.

CASE 4103. Age sixteen months. Examined September 13, 1919. This patient was brought for examination suffering from violent dysphagia, accompanied by paroxysms of coughing and retching. The family history in the case was negative, the birth was normal, the child was breast fed, developed normally, and there were no children's diseases, no discomfort or dyspnea. During the latter part of the first summer there was some distress after nursing which was shortly relieved by carminatives. This patient was weaned one month prior to examination. Immediately following the artificial feeding she began to develop dysphagia which shortly amounted to violent paroxysms of pain. This was relieved by voluntary emesis, the child putting her finger down her throat to empty her stomach. She had been able to retain scarcely any food for the month preceding examination, had lost weight, showed evidence of malnutrition, suffered from the constant vomiting but exhibited no other symptoms. Temperature and respirations were normal, there was no cyanosis or dyspnea.

X-ray examination on September 13, 1919, disclosed a stomach lying above the liver on the right side in its proximal two thirds, the distal one third lying below the liver and these two portions communicating through what would be the normal position of the esophagus (Fig. 1). There is no filling defect in the stomach, the outline is smooth throughout, the pylorus lies in the midline tucked up against the liver. The distal one third of the stomach empties in two hours (Fig. 2), leaving approximately one fourth of the meal in the proximal portion at this time. At six hours (Fig. 3) the stomach is empty and the meal extends throughout the proximal colon. The cecum lies in the middle of the hepatic margin and the ascending colon follows the course of this margin in the usual non-rotated, non-descending position. No other portion of the tract is found in the hernia.

The treatment consisted in diminishing the size and the quality of the formula used, with frequent feedings and careful attention to the hysterical element present. The vomit-

*Read at the meeting of the Pacific Coast Roentgen Ray Society, Catalina Island, California, June 17-19, 1920.

ing disappeared when the proper formula was found, recurring for a few days in October, 1919. Renewed attention to the feeding and sedatives was followed by a complete disappearance of the symptoms. At

FIG. 1. Case 4103. Stomach filled.

FIG. 2. Case 4103. At two-hour distal one third empty; proximal two thirds of stomach full.

twenty-five months this patient has the normal health and development for a child of her age.

The findings in this case check very closely with the position of the stomach in the embryo as seen from its first appearance up to the 11 mm. stage (Fig. 4). The stomach arises as a bulge from the esophagus at about 5 mm. of development and remains in this position, above the liver, until after the fetus attains 11 to 15 mm. At this time the stomach rotates to the left and a diverti-

FIG. 3. Case 4103. Colon filled at twelve hours.

culum appears from the posterior border to form the cardia. As described by Jackson in 1909, "In the 11 mm. embryo the cardia lies opposite the third or fourth dorsal segment," that is above the liver, "while in the 17 mm. embryo the two ends of the stomach have assumed their normal position," that is below the liver (Fig. 5). Interpreted in this light the stomach in this case occupies the position in a 9 mm. embryo with two thirds lying above the liver and the cardia having rotated to the right instead of to the left.

Following further the embryology of the cecum, the normal position of the cecum and appendix in the 95 mm. fetus is in contact with the liver. We have then, in this case, an arrested development in both ends of the tract, the failure of the cardia to rotate to the left and descend to its normal position underneath the liver on the one hand, and the failure of the cecum to rotate and descend from the liver margin to the right iliac fossa. This combines the position of the stomach as found in the 9 mm. embryo and that of the cecum present in the 95 mm. stage.

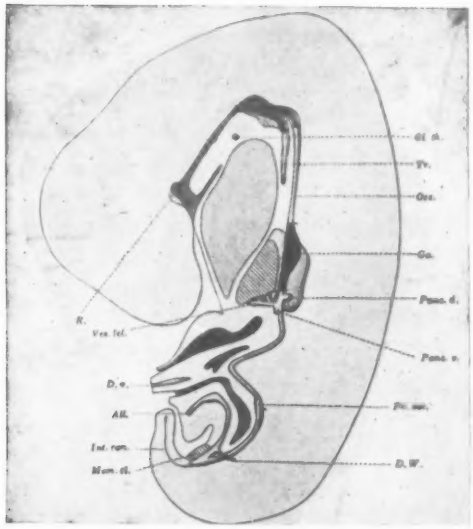

FIG. 4. 9 mm. embryo. Stomach above the liver.

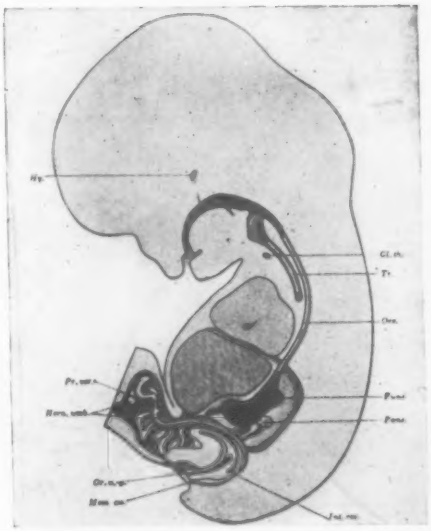

FIG. 5. 17 mm. embryo. Stomach below the liver.

The usual history of incomplete embryonic diphragmatic hernia is either death within the first few days or, passing this stage, the condition remains latent and is not discovered until some accident in adult life. The discovery in the present case was due to the gastro-intestinal upset incident to weaning, and has apparently no bearing upon the health or life expectancy of this child.

TRANSPOSED VISCERA*

By W. O. UPSON, M.D.

BATTLE CREEK, MICHIGAN

IN view of the therapeutic and surgical significance of situs inversus it is surprising to note how little importance is attached to this abnormality by the medical world. Probably no other malformation will cause such marked deviation from the expected findings in diseases of the thoracic and abdominal viscera, and yet the condition has received but slight attention from great students and writers.

In literary study of the subject, one is astonished, and not a little humiliated, to note how small a number of cases have been reported which were detected by physical examination. Prior to 1902, by far the greatest number of cases were discovered on the operating table or at necropsy. Arneille[1] reported the case of a man aged fifty who had been examined five times for life insurance, and yet the complete transposition of his viscera had not been detected. Thierry[2] reported a case in which a thorough examination led to a diagnosis of appendicitis. The regular incision through McBurney's point was made, and the surgeon found that he was dealing with the descending colon. The operation was discontinued, and by a subsequent barium meal the fact was revealed that the cecum and appendix were in the left iliac fossa, and that the case was one of complete situs inversus.

The postmortem examination has led to the discovery of the great majority of cases of situs inversus. A somewhat exhaustive study of the literature on this subject shows that one of the earliest authentic cases was

*Read before the Second Annual Meeting of the Central Section of THE AMERICAN ROENTGEN RAY SOCIETY, St. Louis, Mo., February 21, 1921.

recorded by Petrus Severinus of Rome in the year 1643.

In 1865, Gruber[3], after some laborious research, made a collection of seventy-nine cases of this curious anomaly, five or six of which were discovered during life. Forty-nine of his subjects were men, nineteen were women, and of eleven the sex was not mentioned. In seventy-one out of these seventy-nine cases both the heart and the abdominal organs were displaced, the remaining eight showed displacement of the abdominal organs only.

Küchenmeister[4], in 1893, increased the number of known cases to 149. In 1895, Price[5] had made further researches, bringing the total up to 190, and this comprised all the cases recorded in medical literature up to that year.

Arneille[1], in 1902, made an elaborate study, with the collaboration of a number of internists and anatomists, and reported forty additional cases.

The development of the *x*-ray as a means of diagnosis has facilitated the discovery of this condition in the living subject, and the number of citable cases has multiplied. The first case discovered by the *x*-ray was one of dextro-cardia, reported by Vehsemeyer[6] in 1897. Since that time more than thirty cases have been recorded in which the *x*-ray has been used either to originate or to confirm the diagnosis.

Kerr, in ten thousand autopsies, covering a period of ten years, found only two cases of this anomaly. Bland Sutton reported the discovery of only one case in the course of three thousand abdominal sections.

Because of its importance in the diagnosis of abdominal diseases, it seems appropriate to mention in this connection the condition in which the colon fails to rotate. In this situation the small intestine occupies the right side of the abdomen, and the colon is confined almost entirely to the left of the midline. The cecum is found in the left iliac fossa. Reid[7], in 1836, reported a case of colic and other abdominal pains, terminating fatally, in which the cause of death was given as "ileus". There was no operation. At the autopsy the colon was found to lie entirely on the left side, with the cecum in the left iliac fossa. The small intestines were pushed well to the right. The author does not mention the position of the other abdominal organs. This is apparently the first case of non-rotation of the colon to be reported. In 1916, Dr. J. T. Case[8] reported a case in which there were occasional acute pains in the left iliac fossa. After an *x*-ray study with the aid of an opaque enema, the diagnosis was made of left-side appendicitis, with the colon occupying the left-side position. The operation confirmed the diagnosis.

There are cases of incomplete or partial transposition of the viscera, but, according to Lochte[9], these are far less common than the condition of the complete inversion. Up to 1898 he was able to collect but thirteen cases of this variety. Dextro-cardia may be found with the abdominal viscera in the normal position, or the abdominal organs may be transposed while the thorax is perfectly normal.

Osler[10] claims that in cases of partial inversion of the viscera, and especially that of the thoracic organs, death is likely to occur in infancy.

In an attempt to ascertain the frequency with which this condition is met, I have taken the liberty of corresponding with a number of roentgenologists throughout North America, and a summary of their replies follows:

Dr. Kenneth Dunham. Only two cases, both of these complete transpositions. None within the last five years.

Dr. A. W. Crane. Thinks about three cases to the thousand observations.

Dr. J. G. Van Zwaluwenburg. Two cases of complete inversion, seven or eight of incomplete rotation of the colon, in approximately six to eight thousand observations.

Dr. Wm. H. Stewart. Three cases of complete inversion, two cases of incomplete rotation of the colon.

Dr. Russell D. Carman replies by sending a reprint by Dr. Willius[11] on two cases of

complete inversion, and one of dextro-cardia.

Dr. Lewis Gregory Cole. No cases of situs inversus observed, four or five cases of incomplete rotation of the colon.

Dr. Alfred L. Gray. One case of complete inversion, two of incomplete rotation of the colon, one of dextro-cardia, in which no examination was made of the abdominal organs.

Dr. Arial W. George. Six cases of dextro-cardia, in which no examination was made of abdominal organs. Two cases of complete inversion, three cases of incomplete rotation of the colon, out of 10,551 examinations.

Dr. Edward S. Blaine. Eight or nine cases, all of complete inversion. One of incompletely rotated colon.

Dr. Clarence F. Ball. Cites a remarkable instance of four cases of inversus in one family, including the grandmother on the father's side. Dr. Ball, in conjunction with Dr. E. J. Rogers, is preparing a report of the case.

Dr. G. W. Holmes. Reports that he has not kept definite data, but that he has had five or six cases. "Most of these have been complete, and where there was transposition of the heart the diagnosis had been made previous to the *x*-ray examination."

Dr. Henry K. Pancoast. Reports three cases, in which the heart as well as the abdominal organs were transposed. Also three cases of incomplete rotation of the colon. "In these three cases condition was not known until after *x*-ray examination was rendered."

Dr. G. E. Pfahler. "I think I have seen about half a dozen cases of complete situs viscerum inversus. In all the cases which I have observed the inversion was complete."

Dr. L. T. LeWald. "Altogether I have studied twenty-two cases of complete situs inversus. I have seen one case in which there was a complete situs inversus with an incomplete non-rotation of the colon. I know of one other case of autopsy in a child in which there appeared to be complete transposition and complete non-rotation of the colon. I have seen three cases of complete non-rotation without transposition."

At the Battle Creek Sanitarium there have been observed six cases of complete inversion, two of dextro-cardia, and five of incomplete rotation of the colon, out of fifteen thousand barium meals.

Various theories have been advanced regarding the causes of situs inversus, but these theories are of major importance only to the embryologist and the anatomist and are too technical to be discussed at length in a paper of this kind. A cursory review of some of these theories may, however, be acceptable.

Adami[12] believes that the most likely explanation is that the main current of the blood to and from the germinal area becomes diverted at an early stage of existence, and thus purely mechanical influences cause the vessels on one side of the organism to receive more blood and therefore to grow more vigorously than those of the other side. Karashima[13] propounds the theory that trauma in late embryonic life might cause the malformation.

Another theory is expressed by the term "Cryptoplasmic Variation," in which it is suggested that in the germ-cell there is predilection after the ultimate form of the body, which may induce this abnormality.

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DISCUSSION

Dr. E. S. Blaine. I have observed several cases of situs inversus but every one of these was a complete reversal of the position of both the thoracic and abdominal organs. From my experience I concluded that the statement by German observers that this condition is always a complete transposition was correct. They report no authentic instances of reversal of thoracic viscera with normal position of abdominal organs or vice-versa.

Whenever I find a reversed heart, I give the patient a few swallows of opaque material and invariably find that this enters a right-sided stomach, and from this conclude that all the abdominal organs are in situs inversus. It is very interesting to find that Dr. Upson's work has served to establish that a partial reversal of viscera does occur.

Mr. H. W. Dachtler. Were these hearts normal clinically, or was there evidence of congenital defects?

Dr. L. T. LeWald. As Dr. Upson said, I have seen 22 cases. In the male the right testicle hangs lower than the left. One case was examined by the Army Examining Board. I was in Columbus, Ohio, and had the diagnosis confirmed by an *x*-ray examination made by Dr. C. F. Bowen.

The first case I saw was at Bellevue Hospital, and the transposition was complete. We knew that the transposition involved even the suprarenals and the kidneys, for I performed a postmortem examination.

I have been asked if these people are left-handed. I want to ask Dr. Upson if in gathering his statistics, he has any information on this point.

I have seen a few cases of right-sided heart alone, but usually the transposition is complete.

Dr. W. O. Upson. Regarding the relationship between left-handed people and situs inversus, I have not found anything in the literature, or noted anything in connection with our own cases to suggest that they are in any way related to each other.

The point that I wish to lay emphasis on is the importance of transposition of the viscera, and partial transposition of the viscera in the diagnosis of thoracic and abdominal diseases. I know of nothing that will confuse so much as these conditions, and it is a fact that the physical examination very frequently fails to detect the exact situation, especially in the transposition of the abdominal viscera.

In reply to Mr. Dachtler's question, in our cases the hearts were clinically normal.

REPORT OF A CASE OF DIVERTICULUM OF THE LOWER PORTION OF THE ESOPHAGUS

By H. W. DACHTLER

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THE patient, a female aged thirty-six years, unmarried, was referred by Dr. W. H. Fisher in January, 1920, for an *x*-ray examination of the intestinal tract to determine, if possible, the cause of some obscure abdominal symptoms.

The family history was negative, her father was living and well at eighty-two and the mother living and well at seventy-six. A number of brothers and sisters were all well.

The patient was well as a girl. When eighteen years old she had a mild typhoid infection without complications, and made a good recovery.

Her present trouble began in 1908, with pain in the appendix region and some gastric disturbances, and for six weeks she vomited every time she attempted to take food. During this period she received nutritive enemas. She did not respond to treatment and as the consulting physician thought this a neurosis she was taken to another city for observation and was there operated upon and both ovaries and the appendix removed. These were said by the patient to be diseased but no authentic history of the findings was obtainable. She did not vomit after operation but had much distress in her stomach. She evidently was not completely relieved, for she received osteopathic treatments, and after each treatment "raised much mucous." She gradually got better but has had stomach trouble ever since and has vomited occasionally. In 1916 a cervical adenitis was operated and three months later her tonsils were re-

FIG. 1. Oblique. Pouch slightly posterior and above diaphragm.

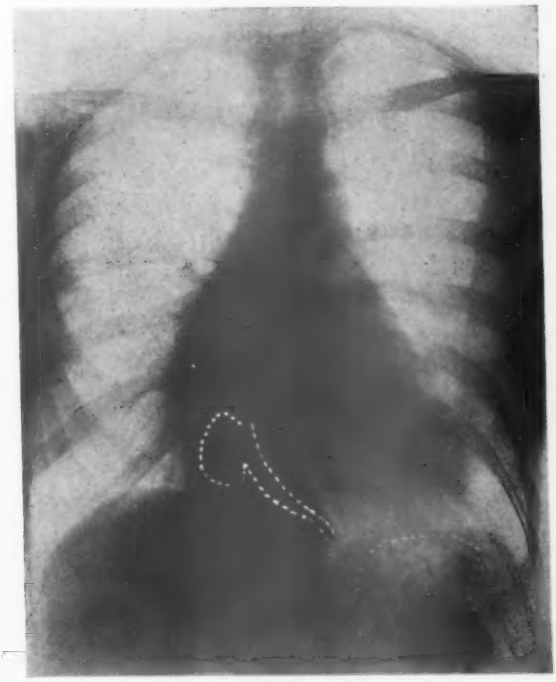

FIG. 2. Anteroposterior. Pouch to right of esophagus.

moved and said to be badly diseased. During 1919 she was worse and lost weight, and she was seen by me in January, 1920.

On examination she was found to have a marked scoliosis, but examination of the lungs was negative and there was no evidence of vertebral disease. The first of the barium meal was seen to enter a pouch to the right of and partially posterior to the esophagus, about four inches from the cardia, and then to overflow into the lower portion of the esophagus and, after some delay at the cardia, to enter the stomach. Throughout the taking of the barium mixture there was some delay at the cardia, but this was not sufficient to cause any dilatation of the esophagus. The stomach was atonic and three inches below the umbilicus, but was otherwise normal and evacuation was complete in five hours. There was very definite delay in the duodenal-jejunal region suggesting adhesions and adhesions around the terminal ileum which also caused some delay in the lower ileum. Later, when the colon filled, marked adhesions were found involving the transverse colon.

April 29, 1920, she was again operated and the adhesions were broken up.

I saw her again in March, 1921, for a sinus examination, and she had gained in weight, looked better and claimed to be much stronger and to have a good appetite and very little stomach trouble. While she claims to have at times some difficulty in swallowing it is hard to elicit any symptoms that can be attributed to the diverticulum. They are more suggestive of a cardiospasm. Patient has refused to submit to examination with an esophagoscope.

This case was reported owing to the apparent rarity of a diverticulum in this region. It does not appear to be a traction diverticulum and its etiology is, to me, uncertain.

TOTAL RADIATION FALLING ON SURFACES EXPOSED TO POINT SOURCES

By JULIUS KAUFMAN, M.D.

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IN our study of *x*-ray physics we noted that there was little if any distinction made between the "intensity" of radiation falling on a unit area,[1] and total radiation falling on a finite area. Very often the same laws, though not applicable, were applied to both. The inverse square law, for example, was often used to compare radiations on similar surfaces exposed to the same source at different distances. Thus it was not uncommon to find it stated without reservation that a surface exposed at twice the distance of a similar surface would receive one fourth the radiation of the nearer surface provided both were exposed to the same source. This is not true. We will show that the farther surface will receive radiation greater than one fourth. As a matter of fact if two like surfaces are exposed to the same source at different distances, the farther surface will always receive greater radiation than calculations based on the inverse square law would lead us to believe. If we wish to compare radiation on surfaces with scientific accuracy, it may only be done by determining the total radiation falling on each surface individually. I have never seen a method of doing this.

I have written what follows chiefly for three reasons:

1. I wished to show a method by which we could determine the total radiation falling on a surface exposed to a point source.

2. I wished to show that the inverse square

[1]By "unit area" is meant an infinitely small area approaching the point as a limit.

law could not be used to compare radiation on surfaces, its use being limited solely to the comparison of intensities.

3. If we admit that the radiation on like surfaces exposed to the same source varies inversely as the squares of the distances, then it must follow that the intensity of similar points on both surfaces bears the same relation. The admission of such a fact is misleading and may lead us into gross errors. We will illustrate just what we mean by a hypothetical case. Suppose we exposed a flat circular surface with a ten-inch diameter, at an eight-inch distance from the source, by overlapping two equal exposures, the targets being ten inches apart, perpendicularly above diametrically opposite points on the circumference of the surface. Suppose we moved our surface to 16 inches (twice the original distance), exposed as before, increasing our exposure time by four. If we were then to compare the intensity of similar points on both surfaces, we would find that they were not equal at all, but that all points on the farther surface received a greater intensity of radiation. The central point on the farther surface, for example, would receive an intensity of radiation greater by 42 per cent than the corresponding point on the nearer surface. When two similar surfaces are exposed to the same source at different distances, the intensities of similar points bear no direct relation to the distances of exposure.

I. THE FALLACY OF APPLICATION OF THE INVERSE SQUARE LAW IN RADIOGRAPHY

Those who apply the inverse square law do it with the following as the basis: They say that the radiation falling on a flat surface at a given distance from a source would fall on four times as large an area at twice that distance. From this they infer that the original surface would receive one fourth the original radiation at twice the distance. This would be so if the radiation over our surfaces were equally distributed. But this is not the case. The intensity on any surface increases as we go toward the perpendicular ray and decreases as we go away from it. Our original surface would get proportionately more radiation if near this ray, and correspondingly less if removed from it.

Flat surfaces, exposed so that the perpendicular ray is central, always receive greater radiation than calculations based on the inverse square law would lead us to believe. If, for example, two 8″ x 8″ surfaces were exposed to the same source for the same period of time, one at 10 inches and the other at 100 inches, the second surface would not receive one one-hundredth (1/100) of the radiation of the first, but actually one seventieth (1/70). That is, it would receive 40 per cent more than calculations based on the inverse square law would lead us to believe.

II. TOTAL RADIATION ON ANY SURFACE: THE VERSIN LAW

Given any surface ABD (Fig.1), receiving a cone of rays from a source S.

To find how much of the total radiation of the source will fall on surface ABD if the total radiation of our source is Q.

With S as a center and R as a radius, circumscribe the sphere, EFG. The cone of rays going to our surface intersects the surface of our sphere in the circle HCL. The plane of circle HCL cuts off a portion of the surface of our sphere HML. Such a surface so cut off is known as a zone of one base. Its area is equal to $(2\pi R) \times (CM)$.

(The area of a zone is equivalent to the circumference of a great circle by the altitude of the zone.)

If R.S., R.Z., and R.X. represent the radiation on the sphere, the zone and the surface respectively, then

$$\frac{R.Z.}{R.S.} = \frac{(2\pi R) \times (CM)}{4\pi R^2}$$, in which $(2\pi R) \times (CM)$ is the area of the zone, and $4\pi R^2$ is the area of the sphere.

$$\frac{R.Z.}{Q} = \frac{CM}{2R}$$

$$R.Z. = \frac{Q}{2} \times \frac{CM}{R}.$$

But $\frac{CM}{R}$ is equal to $\frac{(R - SC)}{R}$, which in turn is equal to $1 - \frac{SC}{R}$, which in its turn is equal to $(1 - \text{Cos. } a)$, so that

$$R.Z. = \frac{Q}{2} \times (1 - \text{Cos. } a).$$

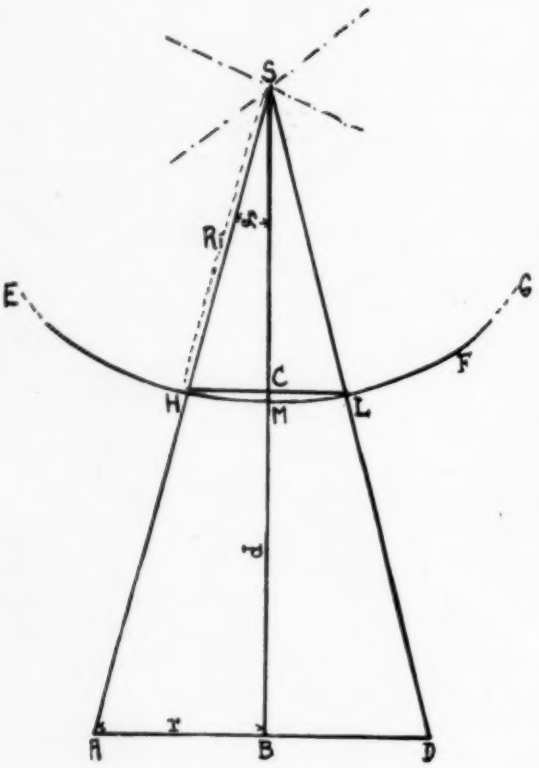

FIG. 1.

But R.Z. is equal to R.X., and $(1 - \text{Cos. } a)$ is equal to Versin a, or

$$R.X. = \frac{Q}{2} \times \text{Versin } a.$$

From the above expressions, we may express the following law:

The total radiation on any surface receiving a cone of rays from a point source is equal to half the total radiation at the source by the Versin of the cone angle.[2]

If the surface exposed be a flat surface, then the expression

$$R.X. = \frac{Q}{2} \times \text{Versin } a, \text{ becomes}$$

$$R.X. = \frac{Q}{2} \times \left(1 - \frac{d}{(d^2+r^2)^{\frac{1}{2}}}\right)$$

in which d is equal to the distance of the surface from the source, and r is its radius.

If we were to expose a flat surface whose radius was 8 inches to a point source at a distance of 10 inches, we would find from the above expression that our surface received 0.11 per cent of our total radiation. If now we removed this surface to a distance of 100 inches it would receive .0016 per cent of the total radiation, and not .0011 per cent which it should receive according to calculations based on the use of the inverse square law. If we had increased our exposure a hundred times when we removed our surface to 100 inches, the total radiation over it would be greater than the total radiation on the nearer surface. If we were to analyze the intensities of points on each surface, comparing corresponding points, we would find that each point on the farther surface, with the exception of the central point, received a greater intensity of radiation. A comparison of the intensities of the central points would show them to be equal. If instead, we had irradiated our original surface by means of overlapping two or more exposures, and had then irradiated a similar surface at ten times the original distance, increasing our exposure by a hundred, a comparison of the intensities of corresponding points would show that the intensity of all points on the farther surface was greater than similar points on the nearer. The above means that if we expose a given area at a given distance by a certain technique, correcting our original exposure time by use of the inverse square law, upon removing this area to another distance, does not insure the same irradiation as originally received. The disparity is at times alarming, especially when the areas have been irradiated by overlapping exposures, when they are large, and when the distance removed is great.

[2]A cone angle is that plane angle which would generate the cone if revolved about one of its sides as an axis.

[3]This expression may be obtained by substituting for the Versin its equivalent in terms of d and r.

X-RAY SPECTRA AND THE STRUCTURE OF MATTER*

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IS ALL matter made of some common elemental unit? If so what is this unit, and by what differences of arrangement are apparently different kinds of matter constructed? These are fundamental questions demanding answers at the hands of the physical sciences.

In the past decade an abundance of data has accumulated upon which very plausible theories have been constructed which attempt to answer these questions. The two most prolific sources of information have been radioactive materials and the electric discharge (or *x*-ray) tube. When the roentgenologist makes an *x*-ray shadow-photograph of a hand, he is generally satisfied with the knowledge of the form, texture and arrangements of the grosser structures of the hand which the radiogram yields. The physicist substitutes for the hand an inorganic crystal and is not satisfied when the *x*-ray negative has disclosed the complete arrangement of the atoms within the crystal, but demands that it also tell the structure of the atom itself.

The rays emanating from the target of an *x*-ray tube are a collection of electro-magnetic waves of various wave-lengths similar to heat radiation, light and wireless waves. They differ only in the length or frequency of their waves. Thus, wireless waves are measured in meters, light waves in thousandths of a millimeter and *x*-rays in ten millionths of a millimeter. Some appreciation of the shortness of this wave length may be gleaned from the statement that if an *x*-ray wave were to be stretched to the length of an inch, the inch by a like stretching would equal the length of the earth's radius.

The fundamental idea whose application has made it possible to separate this mixed bundle of rays into its component wave-lengths is due to Dr. Laue of Zurich, and its application has been ably extended by W.H. and W. L. Bragg and others. It assumes that the atoms in a crystal of pure chemical are regularly arranged in planes with uniform spacing. It should then be possible to use such a crystal in the place of and with the same effect for *x*-rays as the physicist uses the familiar "diffraction grating" for visible light.

Referring to Figures 1 and 2, it will be seen that if the crystal planes are regularly arranged, a reflected beam will arise when the waves from adjacent planes are in the same phase. The path difference of the waves must then equal one or more whole wave-lengths.

Mathematically this is written

$$n\lambda = 2a \sin \theta$$

Where n = a whole number, 1, 2, etc.

θ = the angle of incidence

a = the distance between crystal planes

and λ = the wave-length.

If now the crystal be rotated and the reflected beams be allowed to fall upon a photographic plate, each part of the plate will receive rays of a different wave-length according to the angle θ; and the intensity of any particular wave-length may be found from the relative density of the plate. This photographic representation of the resolved wave-lengths may be called an "*x*-ray spectrum".

a. Line Series Due to Crystalline Structure

If in the crystal there is any regular arrangement of atoms, it should be possible to have several sets of parallel planes. The distance between planes in any one set is the

*Read before the Second Annual Meeting of the Central Section of THE AMERICAN ROENTGEN RAY SOCIETY, St. Louis, Mo., February 21, 1921.

same, but it is different from that between members of any other set. Now if a crystal is mounted with careful reference to the position of its atomic planes and is subjected to a beam of x-rays with only one wave-length, when the crystal is rotated a reflected beam will occur whenever the values of θ and a are such as to satisfy the above equation or whenever $\sin\theta = n\lambda/2a$. Since $\sin\theta$ cannot have a value greater than 1, only those sets of planes with an a-value greater than $\lambda/2$ will be represented by a reflected beam affecting the plate.

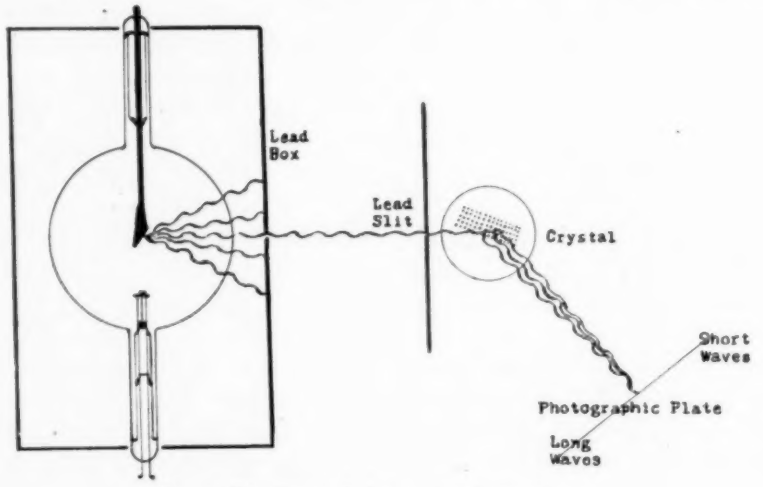

FIG. 1. Diagram of the x-ray spectrometer.

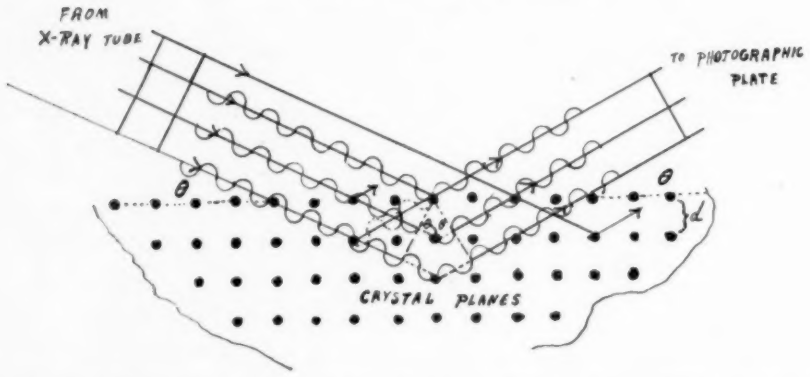

FIG. 2. Diagram illustrating the principles of x-ray reflection for multiple atomic planes.

Drs. Hull and Debye independently suggested that complete chaos of arrangement would do as well as exact uniformity. Dr. Hull, accordingly, pulverizes the crystal, places it in a small tube and backs it with a photographic plate. When exposed to an x-ray beam of a single wave-length, all the possible plane sets are exposed and all the possible lines appear simultaneously on the plate. These lines are due to and characteristic of the atomic arrangement in the crystalline structure of the powder used.

One may now measure the angle θ by the position of the line on the plate, and the wave-length of the x-ray beam being known, one can easily calculate the distance between the parallel planes in each set. Then, knowing the number and the relations of the plane sets, one can reconstruct the geometrical pattern of the crystal and determine the position of the atoms themselves.

In this way, Dr. Hull and others have examined the crystalline structure of innumerable substances and have demonstrated that such physical properties as tensile strength,

hardness, etc., bear a definite relation to the arrangement of the atoms, and that, knowing the arrangement of the atoms, these physical properties can be inferred.

Once the characteristic lines of a crystal have been charted, it may readily be identified again, and since no two chemicals present identical crystalline structure, this chart is characteristic of its chemical composition.

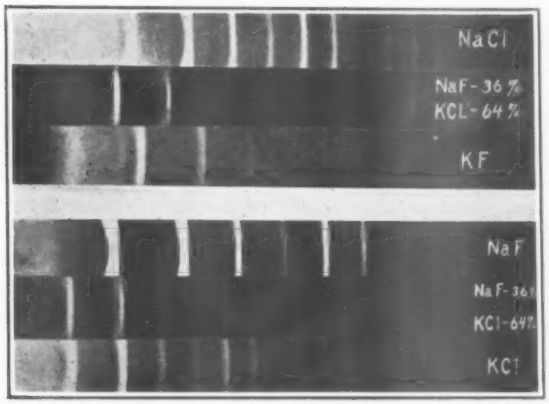

FIG. 3. Spectra of mixed crystals of NaF and KCl. (By courtesy of Dr. Hull.)

Dr. Hull has pointed out the value of this method in the analysis of mixtures of chemicals in crystalline form. This is exemplified in the photograph in Figure 3 representing the spectrum analysis of a mixture of NaF and KCl. Ordinary chemical methods demonstrate only the presence of the four elements and their proportions, but cannot tell in what combinations they exist. It is readily seen that by a comparison with the *x*-ray charts of the pure chemicals no mistake in the combination of the four elements could be made. Quantitative measurements are also possible by the use of comparison samples.

b. Characteristic Lines Due to Atomic Structure

Figure 4 shows the distribution of energy throughout the spectrum of a beam of *x*-ray produced by a tungsten target under various voltages. It will be observed that there is a definite lower limit in the wave-length (on the "blue end" of the spectrum) determined by the maximum voltage. Above this lower limit (towards the "red end") every wave-length is present with some amount of energy, but this energy is not evenly distributed, and it will be noticed that some regions have more energy (represented by an elevation of the line) than those on either side. These peaks or elevations are found to be characteristic of the metal in the target, and if the regions of extraordinary energy be represented by a central line passing through the peak, the "characteristic spectrum" of the emitting metal is obtained. M. Sommerfeld has mapped the characteristic spectra of practically all the metals.

If the corresponding lines of these characteristic spectra are designated by the conventional letters used by Sommerfeld as in Figure 5, certain remarkable relations are found to exist between them.

1. The same lines appear in practically the same order in the spectrum of every metal.

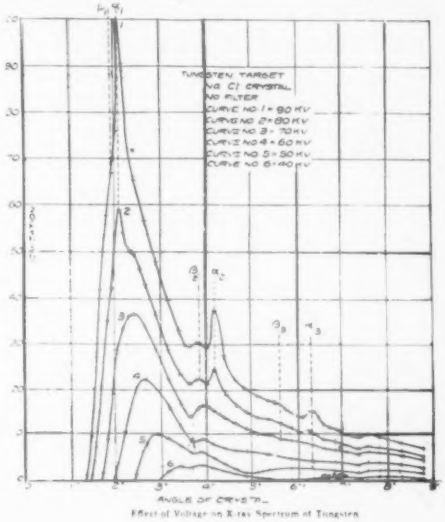

FIG. 4. *X*-ray spectrum and light intensity measured vertically, wave length horizontally. (By courtesy of Dr. Hull.)

2. The wave-length of any particular line grows shorter as the atomic number (and the atomic weight)of the element increases.

3. If the number of waves per centimeter ($1/\lambda$) be used instead of the wave-length, then the difference between various pairs of lines in the same spectrum is the same; as—

$$L_{\delta} - L_{\gamma} = L_{\beta} - L_{\alpha} = L_{\theta} - L_{\rho} = \text{etc.}$$

This ability on the part of the radiating atom to emit its energy in certain definitely related frequencies gives a clue to the structure of the atom itself. On the basis of facts such as these, Bohr, Kossel, and Sommerfeld have developed a hypothetical atom which should theoretically emit and absorb energy exactly as actual atoms do. Figure 6 is the representation of such an atom.

It consists of a positive nucleus, outside of which there are as many electrons as the "atomic number" of the element. The electrons are supposed to be in motion and are confined to shells which may be spherical or ellipsoidal in shape. Mathematical considerations require that the energy of the system be determined by the position of the electrons with respect to the nucleus, being greater for the electrons in the more distant positions, so that the removal of an electron from the outer to an inner ring or shell represents a loss of energy. When *x*-rays are emitted by an atom the energy of the atom must be reduced, and this must mean that one or more electrons have fallen into an orbit closer to the central positive atomic nucleus. This falling in may be produced by the application of an external force, i.e., by means of the cathode stream or *x*-rays. If an electron falls to the inner ring from the next outer ring less energy will be given up than if it fall from the outermost ring. Since, according to the theory of Planck, the energy given up is equal to a constant (h, "Planck's Constant") times the frequency of the emitted wave, a higher frequency and a shorter wave-length will result with the longer fall in the latter case. In each shell there may further be as many ellipses as the serial number of the shell counting outwards from the nucleus.

In the "characteristic" spectrum at least three series have been identified corresponding to three shells; the K, L, and M series, in the order of the increasing wave-length or softness of the ray. When an electron falls from any of the outer rings to the K or inner ring, the K series of lines is emitted, when falling to the L′ or L″ rings, the L series is emitted, etc.

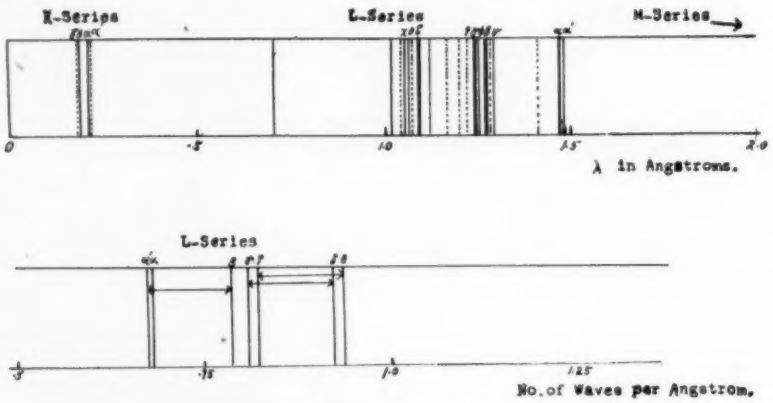

FIG. 5. Diagram of lines in the tungsten spectrum.

Referring to Figure 6 it appears that this structure of the atom readily explains the regular frequency differences just described. For when one compares the amount of energy given up by an electron falling from the inner M ring to the outer L ring with that of one falling from the same ring to the inner L ring, less energy will be emitted in the former case. The first case gives the L_ϵ spectral line. The latter gives the L_η line. The frequency difference in the two lines is thus dependent upon the difference in the L rings. Moreover, this same frequency difference will appear in the spectral lines for every ring outside the L rings from which electrons could fall and give rise to a pair of equidistant "L" lines.

Further it is clear that if the electron must be driven closer to the nucleus to produce

"K" lines than "L" lines, the agent producing such dislocation must possess more energy. In the *x*-ray tube the driving force is determined by the potential applied to the tube and a higher potential must be used to produce "L" lines than "M" lines and still higher to produce "K" lines, and only when it reaches a certain critical value will the "L" lines and the "K" lines appear and when one of a series is produced all of that series and represents the absorption of energy of the atom. This means that electrons are displaced towards an outer from an inner ring. In fact there is evidence that in the atom the outer rings are normally full and if once an electron is dislodged it leaves the range of the nuclear influence entirely. To dislodge an electron from any of the rings would require slightly more energy than that represented by the highest frequency line of that series. If

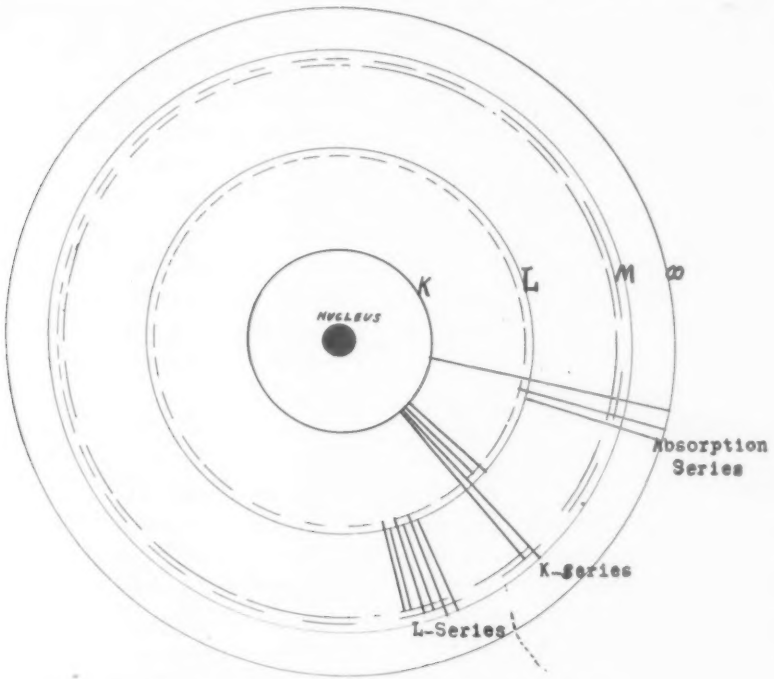

FIG. 6. Diagram of Bohr's hypothetical atom.

should appear simultaneously. This has been experimentally verified.

Further, for the atom of large atomic number (atomic weight) there are a larger number of protecting electrons in the outer shells, since they are presumed to equal the atomic number of the element; and therefore a higher voltage should be necessary to penetrate to an inner ring of the heavier atoms to produce any particular series. This also has been demonstrated.

c. Absorption Bands Due to Atomic Structure

The phenemenon of absorption is in a sense the reverse of the process of emission we pass a beam of *x*-rays consisting of all wave-lengths through a thin sheet of any element, we should expect those wave-lengths slightly shorter than the shortest wave-length of each series in the emission spectrum of that element to be absorbed, leaving dark bands. Bands have been observed for the "K," "L′," and "L″" series of some metals.

Langmuir has pointed out that certain groupings of electrons give more stable conditions than others; for example, two in the inner ring and eight in the second ring represent such a stable condition. This represents the conditions in the element Neon, a singularly inert "noble gas". Just beneath it in order of atomic number is Fluorine

(whose atomic number is 9), with two electrons in the inner and seven in the outer ring; just above it stands Sodium (whose atomic number is 11), with one electron in excess of the stable condition. Neither of these is stable, but if they should come into intimate contact so that the sodium atom could give up one of its electrons to the fluorine (or possibly share it), then each of the two atoms would have the required number for stability. The loss of an electron would leave the sodium atom a positively charged ion, while the gain of an electron would make the fluorine atom a negatively charged ion. Several such ions together due to attractive forces would arrange themselves so that the oppositely charged ions were at the adjacent vertices of a cubical structure. This has been found to be the case by the *x*-ray analysis of the crystals of this substance. Further, when NaF is melted it is found to be an electrolytic conductor, as would be expected if it were a collection of ions.

This theory of atomic structure has still several things to explain. If the electrons rotate about the nucleus they should give rise to magnetic polarity and a collection of atoms should show paramagnetic properties. As a matter of fact, liquid hydrogen has been shown not to be paramagnetic. These objections may be overcome by assuming a vibratory motion or a rotation of the electron about some fixed position of rest.

The idea that the different elements might all be constructed by the combination of individual particles of some mother substance such as hydrogen is not a new one. Hydrogen was first suggested by a British physician, Dr. Prout, as early as 1815. Now after a lapse of a century, scientists are supporting the original theory with very convincing experimental proof. Our conception of the hydrogen atom now is that of a certain nuclear content called the hydrogen nucleus, and one outer electron.

One of the most serious objections to Prout's theory, which has only lately been successfully met, is that if hydrogen is taken as the standard with an atomic weight of 1, the remaining atoms built up of these units should always have the atomic weights in whole numbers and fractional atomic weights would be impossible. As an example to the contrary one may quote chlorine with an atomic weight of 35.46. In recent experiments by Dempster and Aston, it has been shown, however, that such elements with fractional atomic weights are not homogeneous elements but are mixtures of atoms with unlike atomic weights but with apparently identical physical and chemical properties except in respect to their atomic weight. Such elements are called "isotopes." Chlorine is shown to be a mixture of atoms having the atomic weights of 34, 35, 36, and 37. Similar conclusions are drawn in regard to several of the other "elements."

Another objection to the idea of hydrogen being the true mother substance rests on the failure to demonstrate the production of hydrogen on the disintegration of the more complex atoms. Most materials seem to produce or evolve simple multiples of hydrogen, e.g., helium from radium. But in some recent researches, Sir Ernest Rutherford bombarded nitrogen with the α-rays of radium and found quite conclusive evidence of the formation of hydrogen.

I have attempted to tell you in part what the study of the *x*-ray and its use in connection with other problems has played in the progress that has been made by the physicist toward the solution of the problem of the ultimate constitution of matter. But should this theory, or some other that may have to be substituted for it as an explanation of the atomic structure, be accepted as a fact, the scientist is still left with the problem of the constitution of the nucleus and of the electron.

[We wish to acknowledge our appreciation of the kindness of Dr. A. W. Hull, of the Research Laboratories of the General Electric Company, for permission to publish Figures 3 and 4.]

RADIOGRAPHY OF THE MASTOID*

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IT HAS been said that the radiograph is the otologist's best consultant. If it is to be used as so important a consultant it must be considered after obtaining the complete clinical data.

To be of its greatest value it must be the most perfect plate that can be made. Any motion, however slight, will produce a blur and obscure the fine detail of the mastoid cells and will perhaps lead to an erroneus interpretation. One of the prime requisites in taking mastoid plates is that they be taken with the finest focus tube. A plate taken with a broad focus tube at the usual distance is quite as objectionable as motion because of the resulting loss of detail.

The position which gives the most desirable view of the mastoid cells is that first described by Law and later adopted by the U.S. Army. This is in brief: patient lying on the side with the head on a horizontal head holder, the pinna folded forward and the mastoid in contact with the plate, the eyes in a vertical plane, and the tube so placed that the central rays will enter at a point about an inch and a half above and the same distance behind the external auditory meatus of the side uppermost. This superimposes the internal and external auditory meati of the side in contact with the plate, and shows its anatomy with the least distortion and superimposition of the parts. It is for this reason that the anteroposterior position is not advisable.

The resulting radiogram should show the temporal bone in its entirety, but as little of the surrounding area as possible. This can be obtained by using a small cone brought in close relation with the patient's head, thereby eliminating the fogging effect of scattered irradiation seen in plates including more of the skull.

The question of preference between films or plates is usually one of individual taste, although the same wealth of detail and contrast that can be obtained on a plate does not seem to be obtainable on a film.

Radiographs made with intensifying screens, either single or double, no matter how used, are not desirable for mastoid radiography because of lack of detail and contrast, and on account of graininess. Stereoscopic views of the mastoid have the same advantage over flat plates that holds true of stereoscopic plates of other parts of the body. They are, however, a refinement of technique and not a necessity. In the majority of cases the flat plate will yield the same amount of information if carefully studied.

The radiographs of this region require a longer exposure (because of the extreme density of the structures) than those of any other part of the body, and consequently may show motion.

Not infrequently the patient's condition offers difficulties in getting a satisfactory plate. There may be so much post-aural pain that the patient is unable to rest his head securely enough to prevent trembling during exposure, even when held in head-holder. This may be greatly intensified by folding the pinna forward.

Knowledge of the variations occurring in the anatomy of the part is necessary for correct interpretation of the radiographic findings.

The anatomical distribution of the cells cannot be determined from the shape or size of the mastoid process or the external contour of the patient's head. Both the anatomical distribution and cell structure, however, may be shown by roentgen ray examination.

Mastoids are usually divided into three

*Thesis presented on application for membership in THE AMERICAN ROENTGEN RAY SOCIETY.

types according to cellular structure found, namely pneumatic, diploic, and mixed.

The pneumatic cells are to be found in the mastoid and squamous processes and not in the petrous portion. Occasionally we find mastoids in which there appear to be several pneumatic cells coalesced into one large cell area. Law[1] states: "The structure of the mastoids of both sides are, as a rule, similar. Where there is a large cell on one side there will be a correspondingly large cell on the other. This occurs so frequently that we can consider the two mastoids alike in structure."

Diploic cells are always found in the base of the petrous portion about the antrum, although they may extend into the mastoid process, in which they are limited to the region anterior to, or perhaps overlying the lateral sinus. More rarely they extend into the squamous portion.

In about 80 per cent of cases the mixed type are present. In these cases the pneumatic cells always occupy the periphery.

Mouret[2], in his classification, speaks of the "sclerotic" as a type, although he suggests modifying this by the term "compact." A dense mastoid without any evidence of cellular structure is not an anatomical entity,but the result of pathology, and can be readily recognized by the roentgen examination. A clinical history of previous ear infection can always be obtained in these cases.

Cheatle[3] in the examination of over five hundred specimens of the temporal bone found ninety-six, or not quite 20 per cent of the bones to be made up of the fine diploic type of cells to which he gave the name "infantile" because of the extreme thickness of the outer wall and the under-development of cell structure, the so-called "fetal" type which persists throughout adult life.

Bigelow[4] and Gerber[5] have discussed this type comprehensively from a radiographic standpoint.

The otologist has learned from experience that when a small infantile mastoid is involved, he will find a denser outer wall and a relatively thin inner wall at operation. Clinically several possibilities must be considered. The condition may clear up spontaneously; it may travel backwards, breaking through the inner wall into the posterior fossa of the skull; it may enter the labyrinth causing internal ear disturbance; or it may remain in the antrum causing destruction of the lining membrane and ossicles, resulting in chronic otitis media with possible formation of cholesteatoma.

Cholesteatomatus formation occurs most frequently in the region of the antrum and less often in the mastoid process. Ballance[6] states that it may extend into the cranial cavity or internal ear in rare instances.

In acute fulminating mastoiditis, cell outline is lost early and the region becomes quite dense. Later on, destruction may be shown by the appearance of a radiolucent area with loss of cell outline, but this occurs after the lymphatics have cleared away the debris.

In the uncomplicated case, after the acute symptoms have subsided, and the reparative process begins, we find the deposition of lime salts in the region formerly occupied by cell structure, the radiograph now giving the usual picture of sclerosed mastoid.

When infection occurs in the middle ear there is always an outpouring of serum, if not an extension of the inflammatory process into the mastoid cells. This instead of giving normal distinct cell outline gives a diffuse clouding, and follows the infection within a few hours, but may clear up entirely without causing any symptoms referable to the mastoid. Lange[7] speaks of this type as a first degree mastoiditis.

In the second degree mastoiditis, the cell outline is more hazy over the entire distribution and there is, perhaps, at some point in the posterior superior angle of the temporal bone, or in the body of the mastoid process, an area in which the cell outline is lost completely, and in its place appears a white blur. This suggests a destruction of cell outline due either to infection or interference in blood supply. It is not until the lymphatics have begun to clear away the débris that we have an area of diminished density indicative of a process of at least some days' standing.

When destruction of cell outline is general, as invariably happens once a mastoid has begun to break down, the process is said to have reached the stage of third degree mastoiditis.

At any time during the second or third stage of destruction, the inner cortex may become eroded and an abscess form about the lateral sinus. In a certain percentage of cases this condition can be made out on the radiograph as loss of bone structure.

It is not possible to make out subdural abscess or sinus thrombosis as such, although it may be possible to make out the presence of pathology in this area as shown by the destruction of more dense bony structure.

When destruction of the mastoid cells is complete and the infection has subsided, replacement by bone begins. The new tissue can be made out at the periphery of the area of destruction; in some instances it can be made out as early as the end of the first month and may not be complete for several months. The new bone is denser than the surrounding normal bone and has none of its finer texture. This is the sclerosed type of mastoid.

The radiograph is of its greatest value in the course of an acute otitis media developing mastoid symptoms, where the otologist is gathering together his clinical and laboratory findings in order to determine the proper procedure. If the clinical signs are acute and unmistakable, but the radiograph shows no destruction, it would be unwise to wait for this pathology to be demonstrable, for by so doing serious complications may arise.

CONCLUSIONS

1. The best detailed plate possible should be obtained for interpretation of mastoid pathology.

2. A knowledge of the variation in the anatomy as seen radiographically is essential.

3. The complete clinical history and physical findings should be known before an opinion is given.

4. An acquaintance with the possible course in infections of the middle ear is of great aid in interpretation of mastoid radiographs.

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HEAD-REST FOR THE ROENTGENOGRAPHY OF THE ACCESSORY SINUSES*

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SUCCESSFUL roentgenography of the accessory sinuses of the head depends largely upon the carefulness with which the head is adjusted and the tube centered so that the central rays go through the head at the proper place and at the proper angle. Every roentgenologist who is at all careful always uses some instrument of precision in order to indicate the angle of divergence from the base line of the skull along which he projects the central rays. The straightening up of the head to prevent sidewise rotation is usually done by guesswork. Dr. George E. Pfahler presented an instrument to accomplish this purpose at one of the midwinter meetings of Eastern Roentgenologists. The description of this instrument was published in THE AMERICAN JOURNAL OF ROENTGENOLOGY for April, 1917.

The author has devised a head-rest which accomplishes both purposes described; that is, it indicates the proper angle to direct the central rays, and also prevents sidewise rotation of the head. If the head is rotated to one side, the shadow of the petrous portion of the temporal bone on the opposite side is projected into the maxillary sinus. Also, the rays do not go directly through the ethmoid cells, which has the effect of widening the shadow of the ethmoids on one side and narrowing it on the other. If the sidewise rotation is of any considerable degree, the entire maxillary sinus will be blotted out by the shadow of the petrous portion of the temporal bone, and unless the observer is quite familiar with the interpretation of sinus negatives, he may think that this is due to an accumulation of pus in the maxillary sinus. It is not unusual to have a marked lack of symmetry in the two sides of the head and face, and it is often very difficult to judge whether the head is rotated sidewise by looking at it. Further difficulty is encountered in women with long and fluffy hair where the shape of the head cannot be accurately made out.

In order to overcome this, we have devised the head-rest shown in the illustration. This consists of a block of wood such as is very commonly used to rest the head on in making sinus roentgenograms. The angle of the block is 30 degrees from the horizontal. A square metallic upright projects from the face of the block near the upper border. The upright is accurately placed so that it projects at right angles to the face of the block. This is important, since if it is not so placed, the head-holder which slides up and down on this upright will not be parallel to the surface of the block.

The apparatus to level and to hold the head consists of a semicircular bar of metal with a square hole through the middle of the semicircle by means of which it fits on the square upright and allows up and down adjustment. The plane of the semicircle is parallel to the surface of the block. Projecting inward through round holes cut in each free end of the semicircle are two rods terminating in small brass balls. These rods are adjustable and can be fixed by thumbscrews. The entire semicircle is also adjustable on the square upright and can be fixed by a thumbscrew. Lateral rotation of the semicircle is of

*Read at the Midwinter Meeting of the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., January 28, 29, 1921.

course impossible, as the square hole in the semicircle fits accurately over the square upright.

The method of operation of this head-rest is as follows:

The apparatus is placed on a table, or some other level surface, and the patient either lies or sits with the forehead against the surface of the block. The metallic semicircle is adjusted on the square upright until the rods

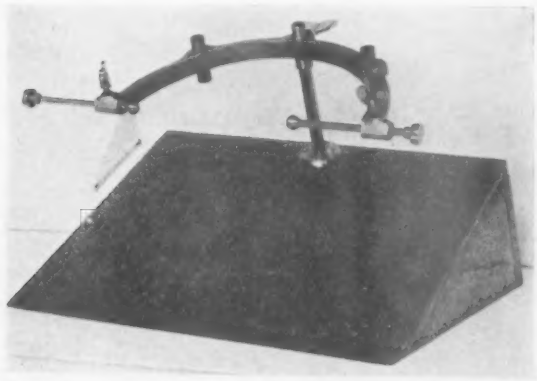

FIG. 1. Head-rest for radiography of the accessory sinuses.

with the brass balls come opposite the external auditory meatus on each side. The rods are then adjusted so that the balls are placed in the external auditory meatus on each side. The thumbscrews are tightened and the head held accurately in this position. Since the metallic semicircle is parallel to the surface of the plate, which in turn has been placed on the surface of the wooden block, the distance from the plate to the brass ball on each side will be the same. As the brass ball has been placed in the external auditory meatus, therefore the distance from each external auditory meatus to the plate will be the same, and if this condition obtains, the head will not be rotated from side to side.

A small right-angled triangle of celluloid or aluminum is fastened between the small brass ball and the rod on one side by passing the rod through a hole drilled in the right angle of the triangle so that the triangle is perpendicular to the rod and the measuring angle points downward. This triangle is used to find the base line of the skull and indicate the proper angle for the central ray. The brass ball being in the external auditory meatus, the rod is rotated until the altitude of the metallic angle corresponds to the base line of the skull—that is, to a line drawn from the external auditory meatus to the glabella. The hypotenuse of the triangle then indicates the direction of the central ray. In practice, I have cut this metallic triangle at 30 degrees and in addition to this, have placed a strip of adhesive plaster across it to indicate to me also an angle of 23 degrees, and in using the apparatus I make one exposure at each angle. I believe this procedure has been of certain advantage. The angle desired can, of course, be marked out on the metallic triangle without interfering with the accuracy of the instrument.

Contrary to expectations, the use of the apparatus has not occasioned any particular discomfort to patients. It is not difficult to adjust and its use has been a great help to me. The apparatus would be improved by making a tunnel in the wooden block so that more than one exposure could be made without moving the patient's head and thus changing the adjustment.

A TABLE DESIGNED FOR THE SIMPLIFICATION OF PNEUMOPERITONEUM TECHNIQUE

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EARLY in our experience with pneumoperitoneum, we were confronted with the problem of securing a technique which, while rapid, would still be sufficiently thorough so as not to miss any important pathological lesions. One of the greatest drawbacks to the more universal use of pneumoperitoneum is the great number of positions in which the patient must be placed in order to secure a view of all the intra-abdominal organs from all aspects.

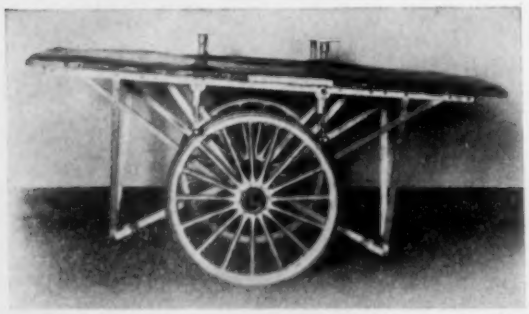

FIG. 1. This table, mounted upon two central wheels, may be tilted readily, the head being raised or lowered by pressure on either end. Two kidney elevators, operating independently, extend through the table top and permit elevation of the patient to any desired level.

FIG. 2. Elevators in position supporting patient under chest and thighs, taking pressure off of the abdomen and allowing the abdominal wall to sag freely forward, permitting examination in the retroperitoneal position.

In the earlier German articles many different positions have been described. Rautenberg[1] in 1914 described the findings in the standing and left lateral positions, and in a later communication of the same year[2] described the appearance in the dorsal and Trendelenburg positions.

Goetze[3] in his paper on pneumoperitoneum gives a summary of the positions previously utilized and goes into considerable detail as to the positions which he considers of greatest importance. He examines patients in the dorsal, standing, both lateral, knee chest and Trendelenburg positions. Early in 1919, Drs. Stewart and Stein in their initial article[4] outlined in great detail five positions with which they felt a thorough examination of all intra-abdominal organs could be made. These positions are briefly:

1. Prone: the tube above, plate beneath abdomen; to give a clear view of the diaphragm, liver, spleen, gall-bladder.

2. Lateral position, with the patient lying on either side to show the clear outline of the kidneys and lateral view of the liver and spleen.

3. A similar lateral view with hips elevated, the patient on either side, tube behind, plate in front; to show the kidneys and lateral view of the pelvic organs. (Fig. 4.)

4. An anteroposterior view with one end of the table elevated, patient prone, with tube beneath and plate above. This position is described as the best for the demonstration of the pelvic organs. (Fig. 3.)

5. The dorsal position, the patient upon his back, plate on one side and tube upon the other, the ray being directed from side to side. This position is the best for abdominal adhesions.

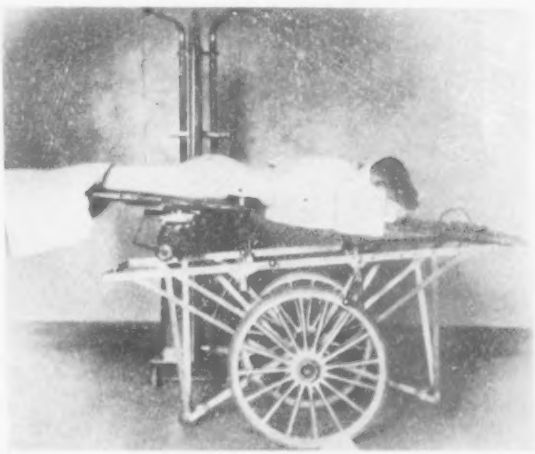

FIG. 3. By inserting a pin, these elevators may be used to raise the entire top of the stretcher at either end to any degree, permitting examination with the tube beneath the table, described by Drs. Stewart and Stein as best for pelvic organs.

Another position for the examination of the retroperitoneal space and for the detection of retroperitoneal masses, was described recently by the author.[5] This consists in supporting the patient in a prone position (Fig. 2), one support beneath the chest and one under the thighs, allowing the abdominal wall to sag freely forward, and thus taking all pressure off the intra-abdominal organs. The intestines and all organs with mesenteric attachment fall downward, leaving the retroperitoneal and prevertebral space clearly visible.

An effort to secure the many positions necessary for pneumoperitoneum is evidenced by the ingenious table constructed for that purpose and described by Orndoff. This table provides for the tilting of the patient at various angles, and the simultaneous movement of the tube and screen so as to examine the patient from all viewpoints. Its very elaborateness and expense are the chief points against its general adoption.

The table which we have adopted for this purpose (Fig. 1), and which while very simple and inexpensive has been very satisfactory, can be briefly described as an ordinary hospital stretcher mounted upon two central wheels, having a shorter support at either end, which allows about eight inches' tilt at the head or foot. Thus by mere pressure on either end of the cart the head of the patient may be either raised or lowered. To this we have added two ordinary kidney elevators of the type commonly found on operating tables, the elevating tracks of which extend through holes in the top of the stretcher and permit elevation of the patient to any degree necessary; one support raising the chest, the other the thighs of the patient, allowing the abdomen to hang freely and permitting examination in the retroperitoneal position. (Fig. 2.)

By inserting a pin these elevators may be used to raise the entire top of the stretcher at either end to any degree—permitting examination with the tube beneath the table, described by Drs. Stewart and Stein as best for pelvic organs. (Fig. 3.)

The other positions are quite obvious. The patient may be inflated while on his back

FIG. 4. A lateral view with hips elevated, the patient on either side, tube behind, plate in front; to show the kidneys and lateral view of pelvic organs (Stewart and Stein).

with his head sufficiently lowered by pressure on the upper end of the cart. He can be inflated while under the fluoroscope by rolling the stretcher before the ordinary vertical fluoro-

scope. The dorsal and right and left lateral positions are secured by having the patient roll first on one side then on the other before the vertical fluoroscope. The entire top of the stretcher is not attached in any way and can be transferred by two assistants with the patient in place to the horizontal fluoroscope. (Fig. 5.)

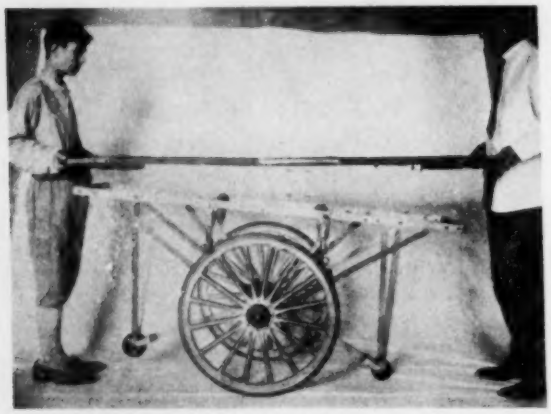

FIG. 5. The entire top of the stretcher is not attached in any way and can be transferred by two assistants, with the patient in place, to the horizontal fluoroscope.

It will be seen then that this stretcher, though simple of construction, will permit fluoroscopic or radiographic examination in all of the pneumoperitoneal positions so far described. The stretcher is not bulky or inconvenient, and when not in use for this purpose can be used for an ordinary stretcher or exposure table. A stretcher of essentially this same construction has been used by us for pneumoperitoneal examinations for the past year with complete satisfaction.

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THE USE OF RADIUM IN THE TREATMENT OF MYXOMATOUS NASAL POLYPS

PRELIMINARY REPORT

By H. R. LYONS, M.D.

Section on Oto-Laryngology and Rhinology, Mayo Clinic

ROCHESTER, MINNESOTA

MY regret to find that the rapidly recurring type of myxomatous nasal polyp does not always respond to medical treatment or surgical measures, led me about two years ago to use radium postoperatively.

Notwithstanding personal advice and literature on the subject to the contrary, nasal polyps frequently recur very soon after their removal surgically. The records in our department show that innumerable cases of nasal polyp have not responded favorably to surgical measures even in the hands of competent rhinologists. One reason that the operative results are not always satisfactory is that the polyp has not a definite pedicle attached to the mucous membrane of a turbinate or a sinus. Removal of this tumor and its pedicle and the nearby tissue or cells does not eliminate the condition, because the adjacent tissue is also undergoing a myxomatous change, which will soon appear in the form of a polyp. The changed area of mucous membrane around the polyp may extend a considerable distance away from the pedicle. It seems, clinically, that surgery in some instances stimulates the formation of polyps in this adjacent tissue.

The polyp which recurs after the removal of a myxomatous tumor which is attached either to a turbinate or involves the ethmoid cells is also of a myxomatous type and frequently is a larger growth than before the operation.

THE ACTION OF RADIUM

It is well known that radium stimulates the production of fibrous tissue, and this action is utilized in the treatment of myxomatous polyps. After one, two, or three treatments by radium, the primary myxoma recurs as a fibromyxoma or a fibro-adenomyxoma. This type of polyp is very much more satisfactory to deal with than is the myxomatous type.

It must be emphasized, first, that radium inserted, for example, into a large solitary nasal myxoma will not cause such a tumor to disappear, nor will it change the type of the tumor; second, radium postoperatively does not prevent the recurrence of a polyp; and third, the use of radium in treating myxomatous polyps associated with a local suppurative process does not cure the latter.

APPLICATION

A hypothetic case illustrating the treatment by and action of radium on myxomatous nasal polyps is as follows: A patient presents himself because of constant nasal obstruction. He gives a history of having consulted a rhinologist four years before, who operated on his nose, removing large masses of jelly-like polyps. He was greatly relieved for a short time, but the obstruction returned and operation for large masses of polyps was again necessary six months after the diagnosis was first made. He has had a total of seven operations for nasal polyps.

Examination reveals a large mass of multiple polyps in the right middle meatus. The polyps are jelly-like and very soft; they appear "water-logged." A specimen is sent to the pathologist, who reports myxomatous polyp tissue. The patient is advised that one or more operations are necessary, and that radium treatments will be used.

A radical operation for the removal of

the polyps is performed and all the polyps are removed with a considerable amount of the adjacent tissue which is not frankly myxomatous, but which, as experience has taught, rapidly recurs as such. As soon as the reaction diminishes, from three to six days postoperatively, radium treatment is given and the patient is kept under observation. Soon some very pale tissue in the middle meatus, not quite healthy in appearance, is noted. Within the next week or two this tissue becomes frankly polypous. Local treatment is continued. In case of recurrence in the remaining tissue a section is sent to the pathologist who reports fibromyxomatous tissue. A second operation, not so extensive as the first, is performed. The fibromyxomatous tumor which resembles a fibroma malle is removed surgically much more satisfactorily than the primary tumor. If the recurrence is extensive the second operation is followed in from three to six days by a second radium treatment; a third treatment is rarely found to be necessary.

DOSAGE

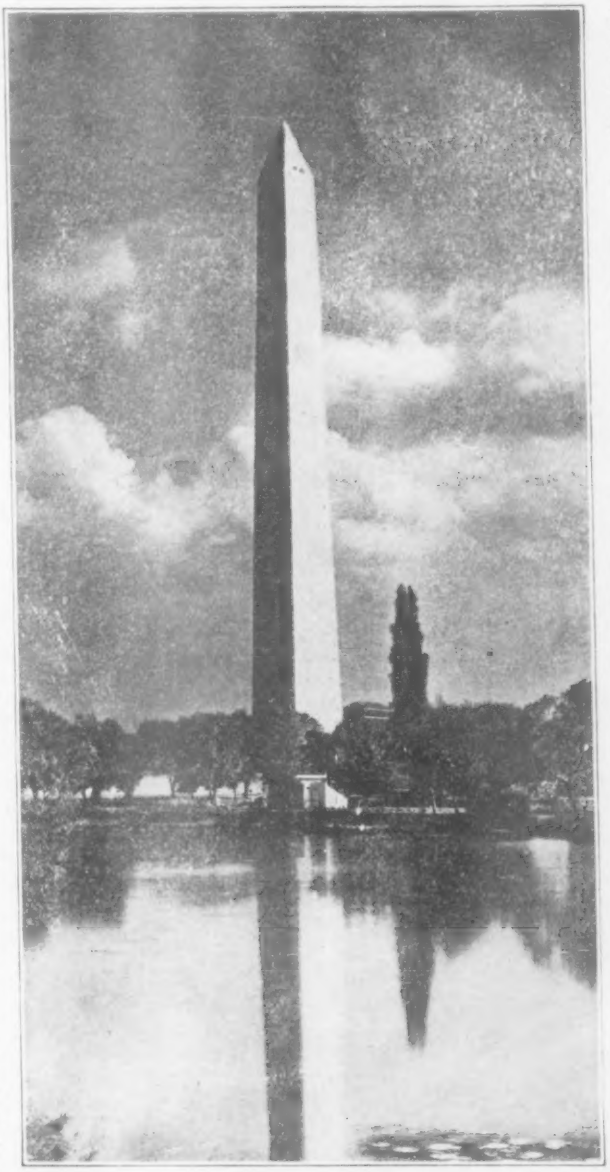
In my early cases I used a 25 mg. tube of radium, screened with a silver tube covered by a sterile rubber finger cot for one hour. Experience gradually eliminated my fear of a burn and indicated that larger doses were necessary. I now use a 50 mg. tube for two hours. Subsequent treatments are given with an interval of one week. The radium tube is put in the region of the myxomatous tissue and made secure by packing with sterile vaseline gauze. The string tied to the radium tube is attached to the cheek by a piece of adhesive tape. After two hours the pack and radium are removed. The reaction resulting from this treatment is not apparent for forty-eight hours or more. In fourteen cases treated with 25 mg. or 50 mg. for two hours no burns occurred.

Conclusions regarding postoperative radium treatment await the test of more time and more experience. I believe, however, that in the stubborn cases of myxomatous nasal polyps, especially those recurring after operative measures, the treatment will result in a change from a myxomatous type to a fibromyxomatous type in which operation may be more successfully performed. Also the polyps recur less rapidly with radium treatment and thus the interval of relief is lengthened.

The detailed report of fourteen cases treated postoperatively since November 1, 1918, will be submitted later.

WASHINGTON

Washington, the capital city of the greatest republic in the world, is universally conceded to be truly the "City Beautiful." It stands alone, not only among American cities but among the capitals of the world, in the noble simplicity of its original design, its spaciousness, its rapid and orderly growth, and its combination of natural and architectural beauty, enhanced by the highest perfection of landscape gardening.



Washington Monument

The city has more than six thousand acres of public parks and reservations. Along its hundreds of miles of streets, ranging in width from 80 to 120 feet, over 105,000 shade trees have been planted, a large proportion of which are in their full growth and luxuriance.

Washington probably has a greater variety of trees, both indigenous and foreign, than any other city in the world, but only seven species are now used. The American elm, the linden, the sycamore, the red and pin oak, the sugar maple and the ginkgo—the first three on the wide avenues, the oaks and maples in many streets and the ginkgo in the narrow streets. These are all grown from seeds from the old trees, sown in greenhouses, and when they have reached the height of 18 to 24 inches they are set out in rows in the government nurseries and later transplanted.

The City of Washington and the District of Columbia are co-extensive and comprise an area of 69,245 square miles. The population is rapidly nearing the half-million mark.

On September 9th, 1791, three commissioners appointed by President George Washington decided that what is now Washington, D.C., should be named "City of Washington in the Territory of Columbia;" also that "the streets be named alphabetically one way and numerically the other, the former to be divided into north and south, and the latter into east and west numbered from the Capitol."

A thousand tourists enter the city every day. No one can fail to be impressed by the great portal of the city, the solid granite Union Railway Station, with its vast passenger concourse, 760

feet long, the largest room in the world under one roof. Trains from North and East, from South and West, all enter this station, the latter through twin tunnels which pierce Capitol Hill many feet below the surface of the street. Should it be the traveler's good fortune to arrive while it is still day he will note the magnificent dome of the Capitol immediately ahead, and to the left the gilded crest of the Library of Congress beckoning a silent welcome, while immediately to the right and connected with Union Station is the City Post Office.

The Capitol seen through the trees.

In the distance, towering against the sky, rises the Washington National Monument, a white marble shaft 555 feet 5⅛ inches in height, which greets the visitor from many different points. An ascent to the top will repay one with a most entrancing panorama of the city, the Potomac River, and even many distant places of interest in the States of Maryland and Virginia.

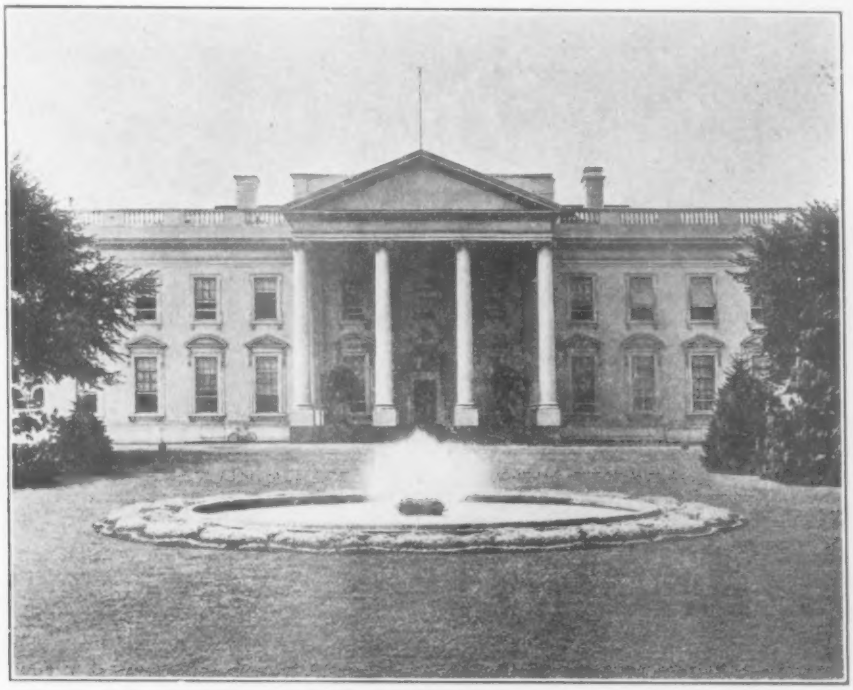
Washington is naturally the home of numerous embassies and legations. The White House, facing Jackson Square at the foot of Sixteenth Street—which is generally spoken of as the Avenue of the Presidents—marks the beginning of imposing edifices extending north for more than two miles, among which may be noted the official homes of the representatives of Great Britain, Italy, Argentina, Cuba, Paraguay, Siam and many other nations.

The city occupies a rather unique position in that it does not encourage industrial pursuits. As the capital of our nation it has ever been considered the central arena of the United States governmental machinery from which the Federal workshops of the various departments direct the activities of the nation. It was, therefore, quite fitting that factories and other unnecessary enterprises be restrained. The Engineer Commissioner of the District of Columbia, an officer of the War Department, appointed by the President of the United States, constantly guards the capital against architectural vandalism and industrial sabotage. It was never intended by its founders to be a populous city. It was to be essentially a political city—a city of government, with the government idea dominating and pervading everything. Its unique and single mission was to be preserved through the centuries, absorbing all splendors and all renown to the glory of the government.

Thus it was to be preeminently the people's city—with every citizen holding the loyal and tender tie of part ownership in all that made it great—in stately buildings, and in fair repute, and sharing with every other citizen his pride in the capital of our common country.

As an educational center Washington ranks second to none. Among prominent institutions of learning are included George Washington University, Georgetown University and Howard University. Another, most interesting, is Columbia Institute for the Deaf, also known as Kendall Green, because in 1856 Amos Kendall gave his home to educate the deaf people of Washington. To-day it contains 153 acres, twenty-eight in beautiful green lawns with fine shade trees, thirty-five in farmland and forty in woodland, together with a large athletic field.

The student here finds ample opportunity to pursue his studies under excellent conditions, for the best libraries of the world are found in the nation's capital. The Library of the Surgeon-General's Office in the building of the Army Medical Museum, contains the largest and most complete collection of medical books in the world, and its Incunabula are second only to those of the British Museum in London. Among other libraries available for reference are the Congressional Library, the Carnegie Library, the Library of the Smithsonian Institute, and many others connected with the various departments of the United States Government.



The White House.

In the arrangement of charitable organizations and well equipped hospitals the capital has just reason to be proud. That ample provision for the indigent sick has been anticipated is evidenced by the splendid buildings, grounds and equipment of the Washington Asylum Hospital, the Children's Hospital, and the gigantic Hospital for the Insane, St. Elizabeth's, just across the eastern branch of the Potomac. Many smaller hospitals abound, all adding to the general scheme for efficiency and beauty, and at the terminus of Sixteenth Street the Walter Reed Hospital is most suitably located near the woods and streams of Rock Creek Park.

And here we find the Home of the Medical Society of the District of Columbia, of which the local physicians are justly proud, many modern high school buildings, the imposing

Mount Vernon.

municipal building, public fountains, private and municipal swimming pools and a magnificent bathing beach, and many other points of interest worthy of comment and praise did time and space permit their connotation.

Washington hostelries have long been noted for excellence of service. Among the oldest and perhaps the largest are the Raleigh, the New Willard, the Shoreham, and the New Ebbitt, all centrally located, and many others readily accessible. The site of the Raleigh was formerly occupied by the Kirkwood Hotel where Vice-President Johnson was living at the time Lincoln was assassinated in the Ford Theater and Seward was stabbed at his home where the Belasco Theater now stands, and an attempt was made the same night to assassinate Vice-President Johnson. The newest and probably the most modern is the Washington Hotel, situated on Pennsylvania Avenue, opposite the Treasury, where arrangements have been perfected for the meeting of the American Roentgen Ray Society to be held on the ground floor. The great assembly hall is undoubtedly the most spacious ever offered (6,500 square feet) and immediately adjoining will be the registration booths, while across the hall are the grill and buffet, where the commercial exhibits will be held. Special rates have been secured for members and friends of the Society.

Among places to be visited by those interested in radium is the National Bureau of Standards, the official home for the standardization of weights and measures. Here radium is weighed and tested before it is finally distributed. The buildings and grounds are situated like a "city built upon a hill," sufficiently removed from human habitation to escape extraneous influences that might deflect the most sensitive measuring devices.

Potomac Drive Way, sometimes erroneously designated the "speedway," is built upon land reclaimed along the banks of the Potomac. Here, in addition to walks, flower gardens, golf links, tennis and polo grounds, are the municipal vegetable gardens, arranged and neatly plotted, free to all.

Many visitors are not aware that, east of the Mississippi River, the great falls of the Potomac are second only to Niagara. Great

Falls is situated fifteen miles north of Washington, and is reached by motor or electric railway. A magnificent series of cascading avalanches forms a drop of 80 feet within a distance of a few hundred yards, carrying over its final precipice a tremendous volume of water.

Sixteen miles below Washington, most picturesquely situated on the right bank of the Potomac, is Mount Vernon, the home of George Washington. Here the First American sleeps in his hallowed tomb and pilgrims gather from every nation and pay tribute to his memory in words or deeds or flowers. The approach by the river, made possible through a well arranged steamship line with regular schedule of trips, lends enchantment to the view, emphasizing the dignity of the mansion with its spacious trees and grounds 125 feet above the landing wharf. Many priceless relics associated with Washington during his life may be viewed there.

Martha Washington's garden, just back of the mansion, with its quaint boxwood hedges set out more than a century and a half ago, is still intact. Some of the plants have lived until now, and there remains to this day a beautiful rose bush, blossoming every year, which was planted by Mrs. Washington, and named the Mary Washington Rose by George Washington himself, in honor of his mother. There is perhaps no more delightful recreation or more instructive relaxation than an outing down the river crowned by a visit to the home of the Father of our Country. Those who prefer to make the trip via the all-rail route of the electric trains may avail themselves of stop-over privileges at Alexandria, eight miles from Washington, and visit Carlyle House and other places of interest, all open to visitors. The round trip by this line may be made in three hours, allowing one hour and twenty minutes on the Mount Vernon grounds.

CHARLES A. PFENDER.

The Library of Congress

THE AMERICAN JOURNAL OF ROENTGENOLOGY
H. M. IMBODEN, M.D., *Editor* · PAUL B. HOEBER, *Publisher*

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Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

TWENTY-SECOND ANNUAL MEETING THE AMERICAN ROENTGEN RAY SOCIETY
WASHINGTON, D.C., SEPTEMBER 27, 28, 29, 30, 1921
Headquarters, Meetings and Exhibits: Hotel Washington. Hotels: Hotel Washington and The New Ebbitt.

TWENTY-SECOND ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY, SEPTEMBER 27, 28, 29, 30, 1921

Published herewith is a provisional and still incomplete program of the Annual Meeting.

As previously announced, the first day of the meeting will be given entirely to papers on therapy with the exception of a short executive session in the forenoon.

Members whose names are not on the provisional program, and who have papers that they wish to present at this meeting will please communicate with the President at an early date, sending the subject and a short abstract of the paper. There is still room on the program for papers of importance.

Executive Sessions.—It is especially important to have a large attendance of members of the Society at the Executive Session to be held on Wednesday afternoon, September 28. Matters of vital importance to the Society will be considered.

Lantern Slide Exhibit.—Space has been reserved and racks will be provided for a large plate exhibit. It is hoped that members will give special attention to this. The educational value of a good plate exhibit, especially to younger roentgenologists, can hardly be overestimated. Photographs, photo-micrographs, and statistical charts illustrating the results of roentgen and radium treatment will add to the value of the exhibit.

Plates, films, and other material for the exhibit should be securely packed and shipped to Major H. C. Pillsbury, M.C., U.S.A., Army Medical, 5th and D Streets, Washington, D. C., to arrive not later than September 10.

Local Entertainment.— Dr. Charles A. Pfender is Chairman of the local committee which will provide entertainement for the ladies and other guests of the Society. Adequate plans are being made for the comfort and enjoyment of all who attend the meeting.

Annual Banquet.—The annual banquet will be held on the evening of Thursday, September 29. It is planned to make the banquet of quite unusual interest this year.

Provisional Program

Cancer of the Uterus. Henry Schmitz, M.D., Chicago.

Treatment of Cancer of the Cervix. E. A. Merritt, M.D., Washington.

Treatment of Brain Tumors by Radiation. Henry K. Pancoast, M.D., Philadelphia.

Progress of Deep Roentgen Therapy. (The Caldwell Lecture.) Dr. Réné Ledoux-Lebard, Paris, France.

Symposium on Therapy of the Thyroid Gland

Radiotherapeutics of Hyperthyroidism. George W. Holmes, M.D., Boston.

Radiotherapy of the Thyroid. A. F. Tyler, M.D., Omaha.

Treatment of Carcinoma of the Thyroid by Radiation. G. E. Pfahler, M.D., Philadelphia.

The Roentgen Ray in Dermatology. George W. MacKee, M.D., New York City, and Henry H. Hazen, M.D., Washington. (Dr. MacKee will discuss the importance of roentgenology in dermatology, the dermatologist and the radiologist, fractional versus intensive treatment, filtered versus unfiltered radiation, idiosyncrasy, medico-legal aspects. Dr. Hazen will cover the treatment of various skin diseases by radiation.)

The Present Status of Deep Roentgen Therapy in Europe, from a clinical standpoint. W. H. Stewart, M.D., New York City.

Therapy of Superficial Growths. Charles F. Bowen, M.D., Columbus, Ohio.

Estimation of the Skin Dosage in Diagnostic X-Ray Work. Arthur W. Erskine, M.D., Cedar Rapids, Iowa.

The Iontoquantimeter in Measuring Dosage for Deep Therapy. Reginald Morton, M.D., London, England.

New Technique for the Vertical Examination of the Sphenoid with Demonstration of the Film Holder. George E. Pfahler, M.D., Philadelphia.

The Stereo-Fluoroscope. James D. Morgan, M.D., Montreal. (Dr. Morgan's stereofluoroscope will be demonstrated under actual working conditions.)

Papers or addresses will be given by W. D. Coolidge and J. S. Shearer on subjects not yet announced.

Pericardial Adhesions. Edwin C. Ernst, M.D., St. Louis.

Paget's Disease; Roentgen Studies Relating to its Etiology and Differential Diagnosis. Leon T. LeWald, M.D., New York City.

Symposium on Education in Roentgenology

Undergraduate Education. F. H. Baetjer, M.D., Baltimore, and H. K. Pancoast, M.D., Philadelphia.

Graduate Education. George W. Holmes, M.D., Boston, L. Jaches, M.D., New York City, and J. S. Shearer, Ithaca, N. Y.

Gastro-enterostomy, Bad After-Effects. A. H. Pirie, M.D., Montreal.

The Present Status of Pneumoperitoneum as a Diagnostic Aid. James T. Case, M.D., Battle Creek, Mich.

The Diagnosis and Removal of Foreign Bodies from Bronchus and Esophagus. Charles F. Bowen, M.D., Columbus, Ohio.

Pulmonary Tuberculosis. L. Jaches, M.D., New York City, and H. Wessler, M.D., New York City.

Benign and Malignant Ulcers from the Roentgenologic Viewpoint. Russell D. Carman, M.D., Rochester, Minn.

Calcification in the Meninges of the Brain. H. M. Imboden, M.D., New York City.

Dental Radiography in the Light of Clinical and Pathological Findings. Allan Scott Wolfe, D.D.S., Washington.

Diagnosis of Internal Derangements of the Knee Joint. Arial W. George, M.D., Boston.

(Subject not yet received.) Willis F. Manges, M.D., Philadelphia.

X-Ray Treatment of Diphtheria Carriers. P. M. Hickey, M.D., Detroit.

Demonstration of Simplified X-Ray Unit for Treatment of Tonsils and Adenoids, Exophthalmic Goiter, Tubercular Glands of the Neck, and Enlarged Prostate. W. D. Witherbee, M.D., New York City.

(Subject not yet received.) J. W. Pierson, M.D., Baltimore.

(Subject not yet received.) Walter Mills, M.D., St. Louis.

Hotel accommodations for members and guests may be arranged at the Washington Hotel and The New Ebbitt. In making reservations state that you are attending the meeting of THE AMERICAN ROENTGEN RAY SOCIETY. Mr. A. Gumpert, Manager of The New Ebbitt, has agreed to see that all those attending the Convention are taken care of. Therefore anybody not getting what he wants should communicate direct with him. It is especially recommended that hotel reservations be made as early as possible.

A NOTE ON THE BUCKY-POTTER DIAPHRAM

At the annual meeting at Minneapolis last September Mr. Wilsey read a paper on scattered radiation and described the method he used for measuring the relative amounts of scattered and direct radiation responsible for the formation of the photographic image. it will be recalled that in the average negative of a thick part covering a fairly wide area (for example, a twenty inch circle) the image-forming rays are only 17 per cent of the total radiation making the picture. The other 83 per cent is scattered radiation.

It is to be regretted that the impression has been somewhat general, since the introduction of the Bucky diaphragm, that this apparatus marks the beginning of a millennium in the making of *x*-ray negatives, absolutely cutting out scattered radiation, whereas its function at best is but to reduce the volume of scattered radiation, hence causing the image-forming radiation to become more effective. The average type of Bucky diaphragm that has been introduced will change the ratio of scattered to image-forming radiation from about 83 and 17 to about 50 and 50, or possibly 65 and 35, or something of that order. Of course this means an increase in the time of exposure.

Mr. Wilsey's paper gives a method which may be readily used for measuring the relative amounts of scattered and direct radiation striking the plate, and it will be a simple matter for anyone interested to make a qualitative test without any additional apparatus other than a small lead cylinder. It is this ratio which determines the effectiveness of any Bucky diaphragm, for the greater the amount of scattered radiation cut out, the greater the time factor. In the average Bucky-Potter diaphragm on the market this time factor is about 3; that is, the exposure with the diaphragm is four times what it is without it, other conditions being the same. If the factor is much less than 3, the diaphragm cannot be effective.

There has been of course some disappointment and criticism since the present Bucky diaphragms have been introduced, but it is the writer's feeling that this has been a good thing for this science, for the manufacturers have had the benefit of a vast amount of constructive criticism as well as a certain wholesome amount of destructive criticism. This will no doubt lead eventually to mechanically perfect diaphragms, for undoubtedly a good deal of the objectionable "corduroy" effect shown in some diaphragmed negatives, due to picturing the grid structure, is caused by lack of uniformity in motion of the grid.

It should also be borne in mind that the efficiency and desirability of any diaphragm of this sort can best be determined by remembering that it is most useful for the raying of thick subjects. There is no desirability of using it for raying thin parts or probably even for raying the thicker parts of an average sized patient, but when the subject is from ten to fifteen inches in thickness, then of course the ratio of scattered to direct radiation is considerably changed and the effectiveness of the Bucky diaphragm is increased.

It is the writer's opinion, then, that the desirability of installing the Bucky diaphragm is a matter to be decided by the individual. It will depend entirely upon the volume of cases requiring radiation of the thicker parts or perhaps abnormally thick parts, and if it is decided that one can be used effectively, then the prime consideration in buying it should be its mechanical perfection.

MILLARD B. HODGSON
Rochester N. Y.

WESTERN SECTION A. R. R. S. REPORT OF ANNUAL MEETING

The Second Annual Meeting of the Western Section of the American Roentgen Ray Society, held at Portland, Oregon, May 27, 1921, brought forth a very gratifying expression of interest in attendence and exhibits. The roentgenologists of Oregon and Washington attended in force, while Califor-

nia was represented by nine delegates. Men from Arizona, Idaho and Montana were also in attendance, bringing the total representation up to about forty. This is an excellent showing, as it comprises about one third of the roentgenologists in the Western Section. The Section joined with the Pacific Coast Roentgen Ray Society in this meeting, and this latter organization took charge of the program on the second day of the meeting, May 28th.

The two organizations were entertained by the Portland Roentgen Club. They were banqueted, dined, and given a four-hour ride over the famous Columbia River Highway—all at the expense of this club of about a dozen members.

The programs were of a high order of excellence, as the papers which will shortly appear in this JOURNAL will demonstrate. The Section received with great enthusiasm the information that THE AMERICAN ROENTGEN RAY SOCIETY will probably come to the Pacific Coast for the 1922 meeting. Plans are already being made for the proper entertainment of the Society in a manner commensurate with its dignity and scientific character.

W. WARNER WATKINS, Secretary

MIDYEAR MEETING OF THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

The Midyear Meeting of the Radiological Society of North America was held at the Copley Plaza Hotel in Boston, June 3 and 4, 1921. The reported attendance at this meeting was larger than that at any preceding similar meeting of this Society.

The scientific sessions, which were well attended, were presided over by Dr. Alden Williams, President of the Society.

The address of Dr. Coolidge on High Voltage Problems, and the paper of Dr. A. F. Tyler on Recent Developments in Deep Therapy Technique—Facts and Fancies, were especially timely.

Dr. Coolidge detailed some of the results obtained by working with two high voltage machines secured from Germany. He stated his belief that the voltages used for treatment in Germany at the present time are not so different from those obtainable from the *x*-ray machines in common use in the United States as we have been led to believe.

He explains the discrepancy by the different methods in use in the two countries of computing the voltage. He gave as his belief that there is as yet no reliable information on the effects of *x*-rays produced by voltages higher than those represented by a ten-inch spark-gap measured between spheres.

A practical conclusion to be drawn from the papers of Drs. Coolidge and Tyler is that the production of *x*-rays by higher voltages than those in common use in this country is still uncertain, and the results of treatment by *x*-rays produced by such high voltage currents are therefore still unknown. It follows that the time has not yet arrived when we should replace the *x*-ray machines now in use by others supposed to produce currents of higher voltage.

The entire program was well-balanced and well repaid the attendance of all who were there.

A. C. C.

CORRESPONDENCE

DR. H. M. IMBODEN, *Editor*
AMERICAN JOURNAL OF ROENTGENOLOGY,
480 Park Ave., New York City.

Dear Sir: In reply to the criticism by J.S. Shearer, published in the March issue of THE AMERICAN JOURNAL OF ROENTGENOLOGY, we wish to state that our formulae and methods of determination of *x*-ray dosage are based on Holzknecht radiometer readings and clinical manifestations of the human skin, also on nearly four years of actual operation in both clinics and private practice with standard apparatus.

Our modification of the radiographic formula $\frac{MA \times V \times T}{D \times D}$ was determined by a series of readings in which we found that

doubling the spark-gap without changing the other factors gave double the dose as indicated by the radiometer scale.

This was clinically verified by exposing different areas of patients' backs instead of the pastille. Those areas in which double the spark-gap of the erythema dose was used and the time of exposure reduced one half, showed the same degree of erythema and clinical manifestations. We therefore adopted the following formula for unfiltered therapy: $\frac{MA \times SpGp \times T}{D \times D}$

We also found that when a filter of aluminum was interposed, it only required twice the time to produce the same Holzknecht reading at full distance as that of half distance.

In order to establish biological proof by doing away with the pastille and substituting the human skin the following experiment was made:

A patient's wrists were exposed with three millimeters of aluminum as a filter, one wrist at a distance of 6 inches from the target and the other at a distance of 12 inches, both wrists being exposed at the same time. The wrist at 6 inches distance was withdrawn after seven minutes and forty-two seconds exposure. The other which was twelve inches from the target received fifteen minutes and twenty-four seconds exposure, i.e., double the time given the wrist at half the distance. Ten days after this exposure the erythema produced on both wrists was identical.

If the exposure at full distance (12 inches) had been made in accordance with the law of "varies inversely as the square of the distance," as in unfiltered therapy, the time of exposure would have been thirty minutes and forty-eight seconds or four times that of half distance.

If an exposure of fifteen minutes and twenty-four seconds at 12 inches produces an erythema, double that time (thirty minutes and forty-eight seconds) will produce an *x*-ray burn; therefore clinically instead of having both areas identical as a basis for determining dosage, one wrist would receive an *x*-ray burn and the other a simple ereythema.

It therefore follows that determinations of filtered *x*-ray dosage based on the same law of distance as in unfiltered dosage would involve disregarding entirely the clinical manifestations of the skin and would ultimately lead to permanent disfigurement, telangiectasis, keratosis and epitheliomatous degeneration of the exposed skin.

Unless some method is devised whereby the law of light and distance and the clinical manifestations of the human skin in filtered *x*-ray therapy coincide, we can see no reason why a law of physics should form the sole basis in determining dosage.

JOHN REMER
WILLIAM D. WITHERBEE.

Subscribers to THE AMERICAN JOURNAL OF ROENTGENOLOGY *visiting New York City, are invited to make the office of* THE JOURNAL (*69 East 59th Street, New York*) *their headquarters. Mail, packages or baggage may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; in this case, kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

BOOK REVIEWS

General Practice and X-Rays. A Handbook for the General Practitioner and Student, by Alice Vance Knox, M.B., B.Ch., with chapters on the production of X-Rays and Instrumentation by Robert Knox, M.D., C.M., M.R.C.S., L.R.C.P., containing 214 pages, 32 full page plates and 56 diagrams in the text. Price $5.00. A. & C. Black, Ltd., 4, 5, and 6 Soho Square, London, W. 1, 1921.

This is a very practical book and should prove very useful to that large class of general practitioners who have not had an opportunity to familiarize themselves with the rapidly developing science of radiography and radiotherapy.

The authors refer to the fact that a general practitioner does not find it easy to keep pace with the new developments in *x*-ray diagnosis and technique, and to appreciate to the full either the help that they can afford him or their limitations. This is especially true of the older practitioners who have been well established in their practice during the early days of the *x*-rays or even before Roentgen's discovery. The authors intend the volume as a practical demonstration of the value of *x*-rays in general practice, without attempting to convey a working knowledge of the *x*-rays.

Reference is made to the position of the radiologist in the field of medicine. He is idealized as a medically trained individual of experience in clinical diagnosis and pathology of that particular field in which he specializes in radiology. His opinion should be of value not only in the interpretation of plates and screen findings, but in the clinical diagnosis and in the prognosis. In other words, the position of the radiological expert is essentially that of a consultant. It therefore follows that the radiologist should be made fully acquainted with the history of the case and the existing physical findings.

The work is readable, clear, attractive from the standpoint of bookmaking, and should be of great assistance in popularizing and extending the usefulness of *x*-ray examinations.

James T. Case.

TRANSLATIONS & ABSTRACTS

PONTANO, T. Contributa alla Conoscenza Clinica e Radiologica della Sifilide Polmonare. (*Policlin.*, 1920, xxvii, 46, 1299.)

The diagnosis of pulmonary syphilis has in the past presented grave difficulties and "phthisis a lues venerea" represented the confused ideas prevalent. Much progress has been made, but even at the present day the clinical syndrome is not clearly defined. It has been demonstrated that syphilis may produce pulmonary lesions of a neoproductive type (gumma), an infiltrative type (broncho-pneumonia), a destructive type (cavities), and a sclerotic type.

Diagnosis at the present time is based on (*a*) recognition of a syphilitic soil, (*b*) contemporary syphilitic manifestations, (*c*) localizations in the lungs and radiographic findings, (*d*) exclusion of other processes, and (*e*) specific therapy.

In pulmonary syphilis roentgenology has not given as much as it might. The roentgenologic character as given in the literature may be summed up as follows: The process has a predilection for the blood vessels, spreads along the vascular ramifications, tends to invade the parenchyma from the hilus outward so that the shadow decreases in density toward the periphery. All radiologists observe that it may be difficult to differentiate between syphilis and tuberculosis.

Pontana reports the case of a man, aged twenty-two, whose clinical history and symptoms are presented in detail. The first roentgenogram taken March 13 showed, on the right side in the region of the second and third ribs and their interspaces, a more or less intense and rounded shadow continuous with the cardiovascular shadow and extending laterally to a point between the midclavicular line and the anterior border of the axilla. While intense, the shadow zones were of varying density and the shadow was not uniform. Its contour was somewhat irregular and its margin gradually blended with its surroundings. Branches extended outward like spokes from the shadow, some of the more prominent ones radiating toward the apex and the base. The roentgenographic picture aided in excluding echinococcus cyst and pulmonary abscess.

After syphilitic treatment another roentgenogram was made, April 2, giving a very different picture. Instead of the former intense shadow there was a trabeculation through which the pulmonary parenchyma could be seen. A portion of the lung had acquired its normal transparency, although there was still a less clear zone near the hilus.

Pontano believes that the roentgenologic examination "permits us to identify exactly the process. The irregularly rounded form with winding margins and the intense shadow with dark and light areas produce exactly the appearance of conglomerate gumma which are observed postmortem." In his conclusions he says that the roentgenologic study is "useful and carries great weight in the differential diagnosis even though insufficient to solve the problem by itself."

A. S. GIORDANO.
R. D. CARMAN.

ANTOINE, E. (Paris.) General and Radiologic Study of Simple Duodenal Ulcer. (*Gaz. d. hôp.*, March 19, 1921, xciv, 23.)

Radiography should always be practiced on the mere suspicion of duodenal ulcer. To corroborate the clinical diagnosis a roentgen examination is of the utmost importance. The art of diagnosis by the rays is a recent acquisition but has been gradually improved. The duodenum and stomach should be studied independently of each other. In the duodenal direct examination a deformity of the duodenum is usually seen, but normal findings do not exclude the presence of ulcer. Much difference of opinion has arisen over the exact significance of this apparent deformity and of the rôle played by local spasm, the latter perhaps modifying the actual deformity. Operation with the diagnosis of marked deformity may reveal only a slight deformity. The author enumerates varieties of deformity as laid down by Carman. The maximum visibility is at the level of the bulb of the duodenum and the deformity is not always easy of interpretation. Naturally any diagnosis based on the presence of deformity requires repeated examinations,

for constancy is the leading element in the diagnosis. If due to spasm a second examination may prove negative in this respect. The indirect or gastric examination is not less important and the diagnosis may be made by it alone. The positive evidences are hyperperistalsis, hypertonus and rapid evacuation. The hypertonic stomach is small, high placed and with parallel walls; hyperperistalsis is visible under the screen, is an intermittent phenomenon as well as inconstant. Rapid evacuation is also brought about by radioscopy, as shown by Barclay. Radiographic diagnosis also includes numerous evidences of duodenal stenosis resulting from ulcer.

Du Pont, J. Slight Fractures of the Base of the Acetabulum. (*Presse méd.*, February 16, 1921, xxix, 14.)

In a recent number of this journal Basset called attention to the possibility that slight fracture of the acetabulum is more common than has heretofore been believed and that this lesion could be confused with contusion of the hip. Slight fracture in this locality with deepening of the acetabulum is an accident which was unknown before radiography. Broca once treated a case in a woman who fell on her great trochanter and presented symptoms which suggested a plastic arthritis. It was five months before the joint became normal. The leading symptom was pain upon pressing upon the great trochanter. Recently a patient was admitted to Broca's service who had been kicked on the great trochanter by a mule. The symptomology was meager—hardly more than a bruise *in situ* and slight local pain. Digital exploration of the rectum disclosed a sensitive area on the horizontal ramus of the os pubis. Earle regards this symptom as evidence of facture of the base of the acetabulum. The *x*-ray showed the correctness of Earle's sign. The head of the femur was in the cavity but the latter was seen to be deepened from fracture through its base. Two spiculae of bone were seen to project into the pelvic cavity. Kantowitsch has called attention to the projection of a single speculae into the pelvis, either superiorly or inferiorly placed, but here, as stated, there were two of these fragments. A slight joint reaction followed the injury and required the use of extension for eight days. The final outcome of the case is unknown. These so-called benign fractures must not be confused with the severe type in which the acetabulum is comminuted and the head of the femur forced into the pelvic cavity. Such accidents were well known in the pre-radiographic period and there is a large literature upon the subject.

Antoine, E. (Paris). A Case of "Appendicular Sciatica." (*Gaz. d. hôp.*, March 1-3, 1921, xciv, 18.)

In 1913, Enriquez and Gutmann described what they termed "limping appendicitis." The author has noticed a close relationship between this affection and the one termed "appendicular sciatica." A patient was seen by him recently with what apparently was sciatica, treated in vain for several months. There was an abortive abdominal symptomatology which did not interfere with the diagnosis. The use of the *x*-rays and a blood count made a diagnosis of chronic appendicitis. The pain was first noted in the heel and was felt higher and higher until it was referred to the right thigh. The pains could not be made to subside and became so severe at last that the patient could neither walk nor work. He then entered the hospital for treatment. The hospital diagnosis was right-sided sciatic neuralgia and the treatment consisted of rest, aspirin, sedative frictions and epidural injection of novococainized serum—all without benefit. The pains always came back as soon as he stepped out on the floor. The hospital physician began to suspect imposture.

When the case came under the author's hands he was surprised to find no tender pressure points, while extension of the lower extremity was but slightly painful. Only abduction of the thigh caused marked pain. Examination of the abdomen left no doubt that whatever else was present the man had chronic appendicitis. Radioscopic examination showed stomach normal, cecum high up and not voluminous, not descending to its normal recess. The margin of the shadow showed deep notches and the base of the cecum was immovable and fixed to the posterior portion of the pelvis in both standing and recumbent postures. The diagnosis was confirmed by the result of operation. In regard to the radiologic diagnosis the fixation of the cecum in the right iliac fossa, irrespective of position, checked up by a tender point at the internal

border of the cecum opposite the appendicular insertion, was sufficient for the diagnosis. An acute exacerbation of an old lesion had set up the syndrome of sciatica.

SCHLECHT, H. (Kiel.) Relative Values of Occult Blood and Radiography in the Diagnosis of Cancer of the Stomach. (*Mitt. a. d. Grenzgeb. d. Med. u. Chir.*, 1917, xxix, 469.)

For early diagnosis of cancer of the stomach the author rates the *x*-ray as superior to most of our diagnostic resources, although temporarily inferior to the demonstration of occult blood in the stools. The roentgen investigation cannot be standardized and may not be available at all. It is further a question whether radiography can determine the stage of development of the cancer. If the two resources are taken jointly with both tests positive we can be certain of our diagnosis in the absence of all other data: and even if the radiogram is only suspicious of cancer, the presence of occult blood will have a notable diagnostic significance. The author cites an unusual case for diagnosis in which there were present a high degree of cachexia, metastases in the liver and occult blood in the stools. The question to be answered was, "Is the primary growth in the stomach or elsewhere?" On both the screen and plate could be seen an anomalous condition of the lesser curvature, the interpretation of which was very difficult. It could have been a carcinoma or merely a perigastric adhesion. As the evidence continued to be inconclusive, a high bismuth enema was taken and a radiogram of the colon taken. The primary growth was seen in the sigmoid and the diagnosis confirmed by autopsy.

LIVIERATO, P.E. (Genoa), The Abdomino-Cardiac Reflex (Sign of Livierato) as a Means for Determining the Tonicity of the Myocardium. (*Grèce Méd.*, December, 1920, xxii, 12.)

Professor Livierato isolates a type of dispensary patient who presents on physical examination no evidence of myocardial insufficiency, but who complains of precordial oppression, with or without dyspnea, especially after a meal. This symptom disappears on moderate exercise. The author made the discovery that this type of patient when repeatedly struck over the epigastrium in the middle line and in the antero-posterior direction showed an increase of cardiac dullness along the right margin. This was especially noticeable in the upper portion, the area of dullness passing upward several centimeters. The outer (left) border remained unchanged. This phenomenon was confirmed by the *x*-ray, both by radioscopy and radiography. It was also shown that after light gymnastic exercise the condition subsided. The author explains the phenomenon as follows: the blows struck abruptly on the abdominal wall provoke a reflex which apparently causes a dilatation of the cardiac chambers, especially of the right ventricle. This fact should imply that somewhere in the circulation an obstruction is present. The possibilities of this kind are so numerous that it is not worth while to state them in detail. It has been shown by Degiovanni by cardiography that ingestion of food, even in the healthy, increases the intrapulmonary tension. As a result of animal experiment the author infers that the blows on the epigastrium cause vasoconstriction of the pulmonary vessels. When this dilatation occurs spontaneously, it is doubtless instigated in subjects with hypotonia of the myocardium, by the mere fact of the ingestion of a meal.

HAMPELN. (Riga.) Symptomatology and Diagnosis of Primary Malignant Growths of the Lung. (*Mitt. a. d. Grenzgeb. d. Med. u. Chir.*, 1919, xxxi, No. 5.)

Some of the author's material evidently antedates the *x*-ray period and he claims that their resource is of no additional diagnostic advantage in the advanced stages, although valuable in the initial period. He enumerates thirteen cases of primary malignancy of the lung and other local affections in which the diagnosis was mistaken, thus giving an idea of the chance of error in both directions. It should however be stated that malignancy of the lung is often complicated with gangrene, bronchiectasis, pleurisy (empyema), fibrosis, etc. There is frequently confusion with tuberculous lesions. In these mistaken diagnoses it does not appear that the *x*-ray figured with a single exception. Here the diagnosis of "cancer" was made clinically. The *x*-ray diagnosis was limited to "neoplasm of the lower lobe." An autopsy could not be obtained.

A case cited by the author is of interest. The patient was an unusually vigorous man of fifty-six in perfect health save for a recent series of hemoptyses. There was dullness of percussion over the manubrium region and the suspicion was of malignant disease. The radiogram showed a shadow given off from the highest point of the vascular shadow with which it was homogeneous. No pulsation was observed on the screen or clinically. This shadow resembled one of aneurysm published by Romburg and another of the same origin by Baetjer. The hemorrhage might therefore have been due to erosion of the aneurysm into a bronchus. Four plates were made over an interval of two months. The shadow broadened with time and toward the right side. Finally the secondary shadow could be seen to be distinct from the cardiovascular shadow, and the diagnosis was changed from aneurysm to neoplasm. The patient survived three months and autopsy revealed a round cell sarcoma of the upper lobe with extension into the right main bronchus.

PAISSEAU AND SOLOMON. Radiologic Aspects of Influenza Pneumonia and Bronchopneumonia. (*Bull. et mém. Soc. méd. d. hôp. de Par.* February 17, 1921.)

The pulmonary complications of influenza have assumed different forms, so that while in one case we see a hemorrhagic bronchopneumonia, in another the lesions are of the frank lobar pneumonic type and less severe. In still other cases there is a pseudo-bulbar pneumonia associated with a diffuse bronchitis and scattered foci of bronchopneumonia. Radiography is an excellent resource for differentiating these three pneumonic types. In frankly lobar pneumonia the shadow shows that the mischief is limited to a single lobe, the borders of which are sharply outlined, and when occurring in influenza the location is for the most part unilateral with a tendency to involve the left side; while a special characteristic is the emergence of the process at the hilus region. American authors have insisted on the latter as a constant feature as a result of early examinations of influenza patients. In typical bronchopneumonia the shadow is characterized by irregular contours the margins of which are less precise and diffuse than in the pseudolobar form. The involvement of the lobules suggests the shadow of a tuberculous lung. The bronchopneumonic form begins at the hilus as in the frankly lobar form with accentuated density and the shadow of peribronchial thickening. By extension there appear small, rounded shadows of diffuse contours, more or less confluent, with a tessellated appearance suggestive of tuberculosis. In certain cases both types of shadow, lobar and bronchopneumonic, may coexist and in these cases the radiologic diagnosis of pseudolobar pneumonia is evident. Characteristic of all of the types is initial invasion of the hilus region.

KNOX, ROBERT. Treatment by *X*-Rays and Radium. (*Brit. M. J.* February 26, 1921, No. 3139, p. 3004.)

X-rays are the best treatment for tinea capitis. In rodent ulcer radium is better than *x*-rays, as there is less frequent relapse after using radium. When it relapses there is resistance to second healing. Lupus vulgaris sometimes gives good results. Too much treatment of it exposes to the danger of lupus carcinoma. Hyperhidrosis is readily controlled by *x*-rays. In leukemia the immediate effect is striking and the control may go on for years, but the final result is nearly always relapse. Radium is better than *x*-rays, as also in Banti's disease. In exophthalmic goiter radium should be used. Simple inflammation of lymphatic glands and lymphadenoma quickly respond, so also with sarcoma, but with the latter relapse occurs. With tubercle and carcinoma the response is slow. In fibromyoma of the uterus reduction occurs to half or a third, but tumors never disappear. Great improvement however occurs in health from cessation of the hemorrhage. Some cases do not respond. In carcinoma of the breast he advised *x*-ray treatment before and after the operation. Some inoperable cases become operable after *x*-rays.

A. H. P.

MORTON, REGINALD. *X*-Ray Radiation and Cancer. (*Brit. M. J.* No. 3135, Jan. 29, 1921, p. 172.)

The author believes that radiation is more likely to provide cure for cancer than anything else. He advocates exact dosage with a 16 inch spark gap and a filter of 12 milli-

meters of aluminum. The Coolidge tube is unsuitable for the treatment. At Erlangen the tube is standardized by biological methods and recalibrated at intervals. A thirty-five minute treatment is followed by redness in a week. No ulcer follows, and tanning occurs after three weeks. This is the unit dose. Taking this as 100, a cancer cell requires 110 to destroy it, 70 to 90 will paralyse it so to speak, and it may recover. A dose of 40 stimulates it to increased growth. Six ports of entry are used for the uterus. This is not possible for breast cases which are treated at a long distance. The treatment may last from five to ten hours. In the Erlangen results dating back from 1918, 20 of 24 cases of uterine cancer were quite well. Since 1917, 75 per cent of the mammary cases are clinically cured.

A. H. P.

A reply to the above (which is heresy) is the following:

JOHNSON, F. HARNAMAN. The immunizing effects of *X*-Rays in Carcinoma. (*Brit. M. J.*, March 5, 1921, No. 3140, p. 365.)

The author replies to Dr. Morton's claims for the Erlanger method of treating cancer by *x*-rays. Neither quantity nor quality of *x*-rays in themselves guarantees success. *X*-rays act by local and general stimulation of the protective mechanisms of the body. It would be dangerous to operate after the Erlangen massive doses. The author advocates instead eight small doses distributed over three weeks. He believes that the *x*-rays act like vaccines, raising the resistance of the patient to cancer invasion. The results of the Erlangen treatment are not convincing. The immunizing effects of *x*-rays are seen in tubercle and Graves disease and he infers from his experience that there is an immunizing effect of *x*-rays in cancer.

A. H. P.

STRÖM, S. (Stockholm.) Roentgen Differential Diagnosis between Osteitis Fibrosa, Solitary Bone-Cyst and Tumor. (*Acta Chirurgica Scandinavica*, December 11, 1920, liii, 2.)

This subject is of great importance, and while the radiologist is presumably familiar with the appearances of the three affections, the latter sometimes shade into one another, and make the problem of differential diagnosis less simple than one would think. In the first case cited by the author the diagnosis of osteitis fibrosa was made only with great difficulty. The lesion was situated in the upper extremity of the humerus and was characterized by extensive deformity of that portion of the bone. In order to exclude the possibility of local neoplastic formation it was necessary to show that the osteitis involves the greater part of the humerus. The author was able to demonstrate from the plate that the structure of the balance of the bone was quite abnormal, even though the gross appearance showed no change. The opposite humerus was studied for control. The deformity, which gave to the bone a club shape, extended downward into the diaphysis and the usual bone structure was obliterated with the suggestion of a cavity formation. The cortical portion in the deformed area was considerably thinned and pressed outward. Upon studying the remainder of the shaft the same thinning of the cortex was evident in places with increase of the marrow cavity, although the diameter of this shaft agreed with that of its fellow on the opposite side. Three years before, there had been a fracture through the upper part of the humerus following a slight violence, and the fracture line was evident in the plate. The decisive feature in osteitis fibrosis is not the structure of the bone but the involvement of the greater portion of the gross non-deformed part of the bone in the morbid process.

HELM. The Tabetic Stomach under *X*-Rays. (*Fortschr. a. d. Geb. d. Röntgenstrahlen*, iii, 25.)

Proof is given in twelve cases that in individual cases at different times completely different appearances may be presented. A connection between the subjective and objective findings with reference to the stomach-picture cannot always be determined. Also in cases subjectively similar, sometimes one sometimes another picture is to be found. In the majority of cases marked subjective symptoms are associated with a radiograph deviating from the normal; above everything, spastic conditions of the stomach are not to be confounded with true hour-glass forms. Very noticeable are the considerable variations in tonus yielded by the

stomachs of individual tabetic patients, where marked atony may alternate with normal tonic behavior. The atonic stomach indicates a pause in the attack.

SIMON. Adhesions in the Cecal Tract Diagnosed by *X*-Rays. (*Hygiea*, Stockholm, lxxx, 241.)

Two cases of strangulation of the lower end of the ileum due to adhesions following an operation for appendicitis which was performed several years previously. For comparison the author refers to 23 earlier published cases of stenosis of the ileum, in 16 of which there was a history of carcinoma or tuberculosis. Whilst the radiograph showed stenosis distinctly in the latter cases, in the two first mentioned there was no real stenosis, but only a slightly retarded filling of the cecum, together with slight dilatation of the lower coils of the ileum and a noticeable distention with gas. These differences, which can be recognized by means of the rays, make a differential diagnosis possible between neurotic nervous troubles after appendicitis and those due to the actual existence of adhesions.

BECERRO DE BENGOA. Radium Therapy of Cancer of the Uterus. (*Annales de la Faculté de Médecine*, ii, 886.)

Supporting his testimony on the treatment of 200 cancers of the uterus treated by radium, the author arrives at the following conclusions:

1. Radium possesses a truly specific action in regard to cancer cells.

2. Vegetative cancers yield more rapidly and are of less serious prognosis than infiltrating or corrosive tumors.

3. Radium often produces pseudo-cures due to an amelioration of the cancer of the cervix, making at the same time an advance in the body of the organ which manifests itself sooner or later.

4. These pseudo-cures are due to an inefficient technique. In fact, if the ideal situation of the radium tube is the cervical cavity, it is nevertheless true that this position can rarely be utilized. More frequently the tube is placed in the vagina, in more or less perfect contact with the external os. The author favors the employment of special thin silver tubes, having four projections on their exterior surface, which prevent them from falling into the vagina. They are placed in position after dilatation of the cervix, and it is then easy to deposit inside these tubes the radium tubes, kept in position by a compress. The cervix and the adjoining tissues are submitted to radiation. There is no danger of cervical occlusion, and all the radiation is absorbed by the neoplastic cells.

LUMIERE, A. The Precision of Radiographic Images. (*J. de Radiol. et d'électrol.*, iii, 97.)

Four rectangular sieves, made of wires of different diameters, were supported 10 cm. above a photographic plate, the anticathode of the *x*-ray tube being 50 cm. away from the plate, and photographs were taken under different conditions of working. It was found that the focal spot is slowly modified in the course of a long exposure, broadening to an appreciable extent. It also suffers a slight displacement when the tube is run for several minutes. In another group of experiments the current strength was varied from ¼ m. amp. to 15 m. amp., the exposure being correspondingly shortened, but the differences in definition were not appreciable. On the other hand, when the tube was softened so that the equivalent spark gap was reduced from 18 cm. to 3 cm., the definition was not so good. Trials with other tubes gave opposite results, and for every tube there appears to be a particular hardness for which the definition is a maximum. It is considered, however, that the variation is not of great importance. Every tube appears to be able to furnish an image, the definition of which depends on the tube, and is little modified by the conditions under which the tube is run. Four photographs taken with the anticathode 30, 50, 100, and 150 cm. from the plate, the exposures varying directly as the square of the distance, show the improvement in definition obtained by increasing this distance.

The experiments relate only to the definition properly so-called; they are not concerned with the degree of contrast obtainable with a tube. For example, a hard tube might give excellent images of all four sieves, but would not be so suitable for examining a case of renal calculus as a softer tube which did not show the finer

wires. As the lack of precision seems to result from the surface of impact on the anticathode not being punctiform, but of an appreciable area, two photographs were taken, one with the tube in the normal position and the other with the anticathode nearly perpendicular to the plate. In the latter case the projection of the focal spot on the plate is a thin line, and the images are greatly improved in one direction. It is concluded, therefore, that one of the essentials for the obtaining of a greater precision in radiographs is the reduction of the size of the focal spot.

LABORDE, A. Apparatus Employed in Radium-therapy. (*J. de radiol. et d'électrol.*, iii, 106.)

This is a general review of the properties of radium and its radiations. Reference is also made to the transformation products of radium. A feature of the paper is a table showing the percentages of soft B, hard B, soft Æ, and hard ¼ radiation transmitted by various metals, bone, and some organic substances, when the thickness of the absorbing material varies from 0.1 mm. to 20 mm.